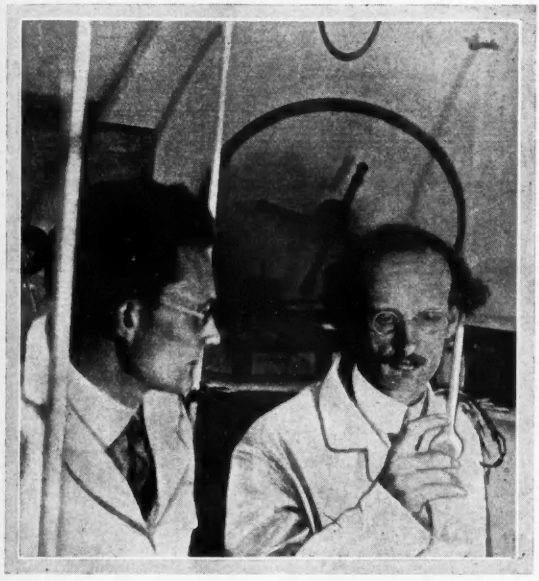
DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XII. No. 139. JULY, 1931. PRICE 1s. NET



PROFESSOR PICCARD'S BALLOON FLIGHT.
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Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor; all questions of advertisements and subscriptions to the Manager.

Offices: Bouverie House, Fleet Street, London, E.C.4. (Closed on Saturday.)

Telephone City 0244. Telegrams: Benbrolish, Fleet, London.

Annual Subscriptions 12*s.* 6*d.* post free anywhere in the world. Single numbers, 1*s.* net; single back numbers more than two years old, 1*s.* 6*d.* net: postage 2*d.*

Binding cases, price 2*s.* 6*d.* net each; postage 6*d.*

Notes of the Month.

Few scientific experiments have aroused more popular interest than Professor Piccard's balloon ascent to a height of nearly ten miles. While attention was naturally attracted by the spectacular aspect of the flight, the uncommon interest taken in its scientific significance is further evidence of the increasing attention which the general public is paying to science. The object of the ascent was the measurement of the cosmic rays at a height at which the rays had not been absorbed by the atmosphere. The physical aspect of the experiment presented the chief difficulty. Since human life is impossible at an altitude of nearly ten miles, it was necessary to construct an airtight laboratory in which approximately normal atmospheric pressure could be maintained. The professor's account of the flight has already appeared in the daily Press. According to *The Times*, the construction of the balloon offered only one striking difficulty. If it were completely filled with gas at the start, it would have ten times more carrying capacity than necessary. This would have necessitated far too heavy a net for supporting the gondola. On the other hand, the balloon had to be nearly full of gas at the start, otherwise the cover would have become entangled in the net. The problem was overcome by doing away with the net, the gondola being directly attached to the balloon. The cover was made of ordinary cotton, covered with a rubber solution. The cabin was spherical in shape and constructed from an alloy of aluminium and tin, hand-wrought and welded. The air was renewed in the cabin by means of two filters, each capable of maintaining adequate atmospheric pressure for eight hours. Owing to the unexpectedly swift ascent of the balloon observations were not possible until a height of over nine miles had been reached. In spite of the difficulties of a first flight, Professor Piccard reports that it was possible to carry out a useful part of his programme. In an article on another page an expert comments on the meteorological value of the flight.

* * * * *

A stone column containing one of the most important Maya inscriptions hitherto found is among the discoveries made by Captain T. A. Joyce, who has recently returned from an expedition to British Honduras in search of Maya remains. Some miles from the coast the expedition came upon two large plazas which appear to have been the site of Maya temples. Of the actual structure only a derelict stone staircase remained. Excavation of another group of ruins revealed two slate coffins nearly seven feet in length, the contents of which had apparently perished. A number of smaller objects include a perfectly preserved spear head and incense burner, some jadeite ear ornaments and a collection of stone implements. The date of the remains is presumably about the fifth century A.D. All the relics are destined for the British Museum, but if a suitable museum should be established in British Honduras at some future date, some of the objects recovered will be returned. We hope shortly to publish a full account of the expedition.

* * * * *

Two notable additions will shortly be made to the equipment at the Royal Observatory. The generosity of Mr. W. J. Yapp in providing the sum of £15,000 for the purchase of a large telescope will make possible the erection of a reflecting instrument with a mirror of thirty-six inches in diameter, and a spectroscope. An additional building and dome will be erected in which to house the new equipment. The need for a new transit circle has long been evident at Greenwich; the existing circle, described some years ago as the

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most serviceable meridian instrument ever constructed, was erected in 1851 and has been in constant use for eighty years. It is now considered to be showing signs of wear, which is not surprising considering the many thousands of observations made with it, and a new transit circle will shortly be erected. According to the report of the Astronomer Royal, the new telescope will be employed in determining the colour-temperature of the stars. Astrophysical work has lately suffered from a lack of up-to-date equipment, for the instrument at present in use was presented to the observatory in 1894.

* * * * *

The announcement that cablegrams reporting the discovery of a child's skull in Mousterian strata have been received from Miss Dorothy Garrod, who is excavating caves on Mount Carmel, foreshadows an important addition to our knowledge of Palestinian archaeology. Until the present discovery the caves had provided the only complete stratification of cave culture in Palestine from the Bronze Age back to the Mousterian period of the Palaeolithic age. The strata include a rich industry of the small flint implements known as microliths, among which was the remarkable image of a fawn carved in bone, the first example of Palaeolithic art to be found in Palestine. The only human remains disclosed before the present discovery are two jaws found by Miss Garrod in Aurignacian strata, lying above and later than the Mousterian, and isolated human teeth of Mousterian age strata. Sir Arthur Keith's hope that human remains would be found in the Mousterian strata have now been fulfilled, and it will be possible to verify his prediction that they would prove to be of Neanderthal types. It will also be possible to compare them with the Neanderthal Galilee skull found by Mr. Turville Petre in 1925.

* * * * *

The decision of the Treasury not to renew the lease of the Royal Botanical Gardens is likely to be followed by the dissolution of a society which has been in existence for nearly a century. Over £50,000 has been spent on the gardens, and the cost of upkeep amounts to nearly £600 a week. In the event of compensation being forthcoming from the Government, it may be possible to acquire another site elsewhere, but at present the financial position of the society is such that the acquisition and laying out of new gardens is out of the question. At a meeting of fellows to review the situation, proposals regarding the future of the gardens were discussed. It was suggested that the existing botanical, horticultural and educational side should be retained and the amenities in respect of plants and flowers developed. Proposals were also made for the continuance of the society itself, with fresh support from the public, a membership which would carry certain rights of admission to the gardens, a general charge of three-pence for admission of the public and the institution of two free days a week. The Government has several schemes "under consideration," the most attractive of which is probably the establishment of an open-air folk museum; at least the society has been informed that nothing will be done to interfere with the beauty of the gardens. While in the circumstances there appears to be scant prospect of the society's continuing, visitors to the Royal Botanical Gardens will regret the dissolution of an institution which has flourished for so long and has done much excellent scientific work.

* * * * *

A new catapult for launching airplanes is likely to solve the difficulty of taking-off in restricted areas. At a recent demonstration a machine weighing over seven tons was released into the air at a speed of about sixty miles an hour within three seconds, after a run on the ground of only a hundred feet. A run of about a thousand feet is normally required. A catapult for releasing airplanes from ships is already in use but has so far been confined to small craft, and the projection speed is only forty miles an hour. The ultimate possibilities of the land catapult are obvious; in the meantime the device is likely to prove of great assistance in taking-off after a forced landing in cases where there is not at present sufficient accommodation for the necessary run.

* * * * *

Sir Flinders Petrie's recent lectures on the past season's excavations in Palestine of the British School of Archaeology in Egypt are of special interest in the light they throw on the Hyskos. The excavations have established the fact that the so-called Shepherd Kings are no longer to be regarded as mere nomad dwellers in tents, but were the settled inhabitants of a city greater in extent than Troy. They commanded the road from Palestine to Egypt, and it would appear that they possessed harbours and had developed a system of weights and measures. The city was therefore a great centre of international trade—the emporium of Asia and Africa. In this connexion we may call attention to a letter in *The Times*, signed by former pupils of Sir Flinders, in which they urge that a fitting recognition of his great services to archaeology and the early history of civilization would be the provision of scholarships affording facilities for the further training of archaeological students in the field.

A New Monumental Work on Biology

By Julian Huxley.

An important new book on biology is here reviewed by Professor Huxley who considers it to be a monumental work. The book contains a vast amount of material useful and interesting both to the layman and the professional biologist, but the writer criticizes the scanty treatment which many new developments receive.

SIR ARTHUR THOMSON has long been distinguished for the astonishing range of his reading and knowledge in general biology, his particular interest in animal behaviour as well as in natural history and geology in its wider sense, and his cautious fairness in stating the major problems of evolution. His latest book,* written jointly with Professor Patrick Geddes, is a monumental work. Having recently been engaged as part author upon a somewhat similar task (whose result, however, was shorter than these volumes by twenty-five or thirty per cent), I can appreciate its monumental nature to the full. Professor Geddes is well known for his interest in regional study, for his fondness for sociological theorizing and for his almost prophetic zeal.

The volumes just published reflect their authors' characteristics. Of the twelve major chapters after the brief introductory two, the first and one of the longest is headed "Ecological." There is one on behaviour, styled "Biopsychological." There are two on Evolution, in addition to one on Reproduction and Sex and another on Development. And at the end, after a brief Biology of Man, there follow two essentially Geddesian chapters on "Biology in its Wider Aspects" and "Towards a Theory of Life." When I say Geddesian, I mean that they contain sectional headings of this type :—"Psycho-biological Concepts and Mytho-poesy"; "Resulting Claims for Bio-social Synthesis"; or "Logic and Technique of the Life-graph."

Defining Biology.

Besides the chapters I have mentioned there are the introductory ones defining biology and summarizing the authors' views as to the nature of life; a long chapter styled "Physiological"; a curiously short one on "Organic Form and Architecture"; and another very Geddesian chapter on "Biology among the Sciences," containing for instance "The Sub-sciences of Biology; their Mapping-out applied to the other Main Sciences; Humanization of Specialities towards Unity of Science; The Organismal View in Physical Science." And finally there are four appendices—two historical, one on biology in education, and one consisting of a very useful bibliography covering twenty-five pages. It will thus be seen that the work covers the range of biological phenomena in a grandiose sweep, and that it devotes an unusually large proportion of its space to sociological generalities and scientific methodology.

Results of Long Reflection.

Here is a great body of fact and critical discussion brought together in a single compass, notably on the more general aspects of ecology and comparative physiology, animal behaviour, reproduction and evolution. The layman will at once realize that he is enjoying the results of great erudition and long reflection, expressed in a picturesque and on the whole easy style; the professional biologist will continually be finding some unfamiliar item of fact, some interesting interpretation, some reminder in the shape of all-round discussion, of the dangers of one-sided or hurried theorizing. Whatever criticisms one may make, the work is a monumental one; it does epitomize the life and labours of one of our most all-round and reflective biologists; and if it cannot be said to sum up a biological epoch, it sums up one aspect of an epoch.

Yet when all is said, certain doubts and criticisms remain. The first and gravest doubt is this: for whom really are these volumes intended? We cannot suppose that they are intended primarily for the professional biologist; they are neither full enough nor technical enough for that. Nor can we suppose that they are meant to be Popular Science in the ordinary acceptance of that phrase, addressed to the ordinary man in the ordinary street; for him they are a good deal too detailed, and much too difficult in parts, while they also presuppose a certain basis of elementary biological knowledge. We can therefore only suppose that they are intended for that section of the public who will be interested in the philosophical bearings of biological questions and the pros and cons

* *Life: Outlines of General Biology.* Two Volumes. (Williams & Norgate. £3 3s.).

of biological theories, and are well-educated enough to know a little biology already. This is a limited section, and I cannot help feeling that the authors could have made their book more valuable by adopting either of two courses—either the further elaboration of the book into a real " Principles of Biology," with more limited sale but more lasting influence on thought; or its condensation and distillation into a shorter and more truly popular work, exerting its influence from below rather than from above.

Paucity of Illustrations.

To give point to this criticism, a serious defect in the make-up of the book must be mentioned—the paucity (and on the whole poor quality) of the illustrations. There are only 202 figures all told—one for every 7½ pages; and many of them are purely symbolic diagrams. This appears to be deliberate on the authors' part. At least, on page 751 we read, after a longish and wholly unillustrated account of that very complex process, the early development of an Amphibian: " This preamble . . . will become clear if good figures are carefully studied." That is to say, the reader of the book is supposed to have access to biological text-books, and not to find in the volume before him a compendium which is to be complete, so far as it goes, in itself.

There are two other major criticisms which may, I think, be made. One is the disproportionately large amount of space allowed to what may not unfairly be called Geddesian generalization; the other, the disproportionately small amount of space allowed to the more recent and especially the more accurate and quantitative branches of biology. Sir Arthur Thomson is known as the author of a comprehensive treatise on Heredity, which in its time was very up-to-date. It is accordingly all the more astonishing to find the recent developments in the field of Heredity, which have made of that sub-science the most accurate and exciting of all the branches of general biology, dismissed in a few scattered passages. There is no mention in the index of allelomorphs, multiple factors, modifying factors; in the text even Mendel's two laws are quite inadequately dealt with. I defy any layman to use the index or the contexts so as to dig out for himself a coherent account of elementary Mendelism. Similarly, while the accurately measurable respiratory quotient is dismissed in a paragraph, great play is made with theories of evolution and sex based upon the metabolism ratio " A/K " $= \frac{\text{Anabolism}}{\text{Katabolism}}$; it will be long before the reader discovers that this ratio is not capable of being formulated, at present at least, in quantitative terms at all. This fondness for formulae which give an illusion of accuracy, but are in reality only shorthand notations for quite general and essentially non-quantitative ideas, is revealed throughout the book.

It is impossible to enter into detailed criticisms of a work of this scope. I may mention, however, that our authors still cling to the distinction, now generally abandoned, between " fluctuations " and " mutations " as two different *kinds* of germinal variations. And a very curious attitude is revealed on page 1098 where they are attempting to discount the role of chance in evolution and heredity; apropos of the random segregation of chromosomes at the reducing division, they say " the smallness of the fortuity here may be inferred from the fact that it is in the reducing or meiotic division that the phenomena of Mendelian Inheritance find their explanation." But both of Mendel's laws are the numerical expressions of certain workings of pure chance in the strictest sense of the word!

Sir Arthur Thomson has previously contended that no healthy free-living animal is ugly, and he repeats the assertion here: I commend him to the hyaena. He has a most interesting discussion of regeneration, and performs useful service by reminding iconoclastic modern biologists that many cases of regeneration are adaptive; but it is scientifically disingenuous to omit all mention of the numerous experiments, such as those of Morgan on hermit crabs, which show that in other cases it can be definitely non-adaptive. The discussion of evolutionary theory is made less easy for the general reader by the fact that Thomson inclines to neo-Darwinism, Geddes more to neo-Lamarckism; in their attempts to be fair to each other and to everybody else they not seldom end by leaving a feeling of general vagueness.

Admirable Sections.

It must not be imagined from these criticisms that there are not many sections which are wholly admirable, or that the book does not throughout contain a vast amount of material useful and interesting alike to the intelligent layman and to the biologist. It does do so; and it will undoubtedly fill a useful place in many libraries. But the general feeling still remains—the feeling which prompts the reviewer to ask for whom the book was intended—that with a little more planning and especially a little more labour in condensation and in illustration, the book could have been transformed from a meritorious, interesting and useful work into one which was outstanding, compelling and indispensable.

The Balloon as an Aid to Science.

By F. J. W. Whipple, M.A., Sc.D.
Superintendent of Kew Observatory.

Professor Piccard's balloon ascent to a height of ten miles makes it appropriate to consider the part played by the balloon in scientific research. Observations made by this means gave the first information about the constitution of the free air at great heights, its temperature and humidity. There is still scope for the use of manned balloons for investigations in meteorology and especially in atmospheric electricity.

"No sooner had the brothers Montgolfier launched into the air their first aerostatic globe, no sooner had the art of aerial navigation dawned, than certain contemplative minds saw at once the immediate application of this noble physical conquest to the investigation of the vast atmospheric ocean at the bottom of which we live. This splendid and marvellous means of locomotion was at once hailed as an infallible method of obtaining a thorough knowledge of the earth's atmosphere; and though some were bold enough to believe, at this early date, that the course of a balloon might be directed at will and that pleasure trips to all parts of the world might be easily accomplished, others of more sober imagination looked only to the scientific applications of the new discovery."

So runs the opening paragraph of the section contributed by Flammarion to "Travels in the Air" which was edited by James Glaisher and is a mine of information with regard to the early history of ballooning. In the second edition of this book Glaisher described the measures taken in Paris during the siege to maintain communication with the outside world by balloons. The number of balloons which left Paris between 23rd September, 1870, and 28th January, 1871, was no less than sixty-two. I refer to this to recall the broad-minded action of the French Government in placing a balloon at the disposal of the astronomer Janssen to enable him to go to Algiers to observe an eclipse of the sun, a unique example of the use of the balloon as an aid to science. Janssen left Paris on 2nd December, 1870, carrying several dismounted telescopes, and landed safely at St. Nazaire at the mouth of the Loire. Whether the enterprise was rewarded by good observations of the eclipse Glaisher does not say.

Early Developments.

Although it was demonstrated by Black at Edinburgh in 1767 that a bag filled with hydrogen would rise in the air, it was not until 1783 that balloons were developed: fire balloons and hydrogen balloons were in the experimental stage together. The first fire balloon to carry human beings was sent up near Paris on 21st October, 1783, and within two months a hydrogen balloon with two passengers ascended from the Tuileries. Numerous ascents followed; Flammarion mentions fifty-two in 1784. Later he mentions that "no public entertainment has been considered quite complete without its balloon ascent. Smaller gaieties go off with a little fire balloon, but the larger ceremonies require a real air balloon and an aeronaut in flesh and bones."

The First Ascents.

The possibilities of scientific research in the air may have been foreseen even before the first ascents, but hardly any observations of permanent value were made until 1804, when Laplace proposed to the French Academy of Sciences that advantage should be taken of balloons for solving certain physical problems, notably that of the intensity of magnetic force at great heights. Two ascents were made by Gay-Lussac on behalf of the Academy. In the first he was accompanied by Biot, and the rotation of the balloons was found to interfere with the observations of the magnetic needle. In the second ascent Gay-Lussac had long hanging ropes to clamp out the spinning of the balloon, and his magnetic observations were successful.

The mean observation of the oscillations of the needle at all heights was forty-two seconds, and he concluded that magnetic force does not undergo any notable change even at the greatest heights to which we have access. Glaisher in 1864 found that the period of oscillation of a magnet increased at great heights, but he does not say in his book whether the change could be accounted for by temperature variations. Whether the experiment has been repeated with due regard to such details I do not know, but I suspect that Gay-Lussac's conclusion was the right one.

Of more general interest was Gay-Lussac's demonstration that the composition of the air was constant up to 23,000 feet above sea-level; he brought

down air collected at that height and had it analysed. It might have been expected that the lighter of the constituent gases would be in excess at that height, like the cream in the upper part of a glass of milk. In that case the proportion of nitrogen would have increased and the proportion of carbonic acid gas would have decreased. The experiment, which has been confirmed by other investigators, proves that the air is pretty well stirred.

Gay-Lussac's careful observation of temperature must also be mentioned. At a height of 23,000 feet the temperature of the air was 15° F. At the beginning of the ascent the temperature of the air was 82° F. Using the terms adopted by Sir Napier Shaw, we say that the lapse of temperature was 67° F. and the average lapse-rate was nearly 3° F. per thousand feet. We know now that this is not far from the mean value of the lapse-rate in the lower atmosphere. It is worth noticing that if a dry atmosphere were thoroughly stirred the lapse-rate would become 6° F. per thousand feet. This lapse-rate or a little more is observed in the air from ten feet or so upwards on a sunny day. Gay-Lussac's observation is explained by the success of radiation, evaporation and condensation in keeping down the lapse-rate.

PREPARATIONS FOR WELSH'S ASCENT.
This quaint old print shows the equipment used by John Welsh in one of his ascents from Vauxhall Gardens in July, 1852. Welsh is on the extreme right, wearing a cap.

From 1804 to 1852 there were, it appears, few scientific expeditions in balloons. In the latter year John Welsh, a young man who had recently been appointed Superintendent of Kew Observatory, made four ascents under the auspices of the British Association. In Welsh's equipment special importance was attached to the good ventilation of the thermometers and he obtained some excellent observations which confirmed on the whole the persistence of the average lapse-rate of 3° F. per thousand feet. Welsh died in 1859, and it was not until 1862 that the observations organized by the British Association were resumed with James Glaisher, already a veteran meteorologist, as observer. Glaisher and his companion Coxwell should be ranked among the heroes of science.

It was on 5th September, 1862, in their third ascent, that they reached a height estimated at 37,000 feet. It will be remembered that at a height approaching 29,000 feet Coxwell had to climb up into the ring above the car to release the valve line which had become entangled and at the same time Glaisher became unconscious. He writes: "I suppose two or three minutes to have elapsed between my eyes becoming insensible to seeing fine divisions and 1h. 54m." (the time of the last observation of the barometer) "and then two or three minutes more to have passed till I was insensible, which I think therefore took place about 1h. 51m. or 57m. Whilst powerless I heard the words 'temperature' and 'observation,' and I know Mr. Coxwell was in the car speaking to and endeavouring to rouse me. . . . I resumed my observations at 2h. 7m., recording the barometer reading at 11.53 inches and temperature −2° F."

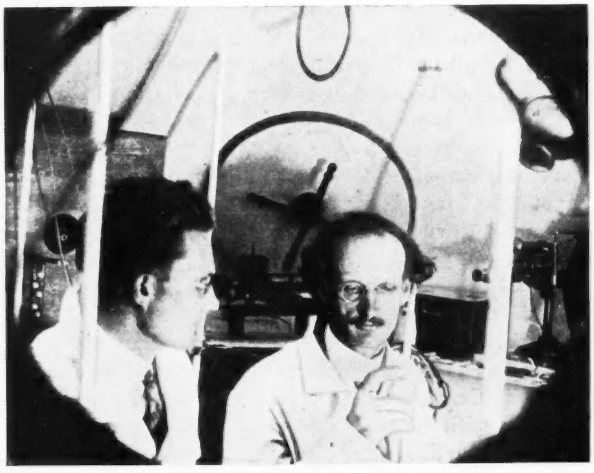
Coxwell had just escaped insensibility. To open the valve he seized the cord with his teeth and dipped his head two or three times. Neither Glaisher nor Coxwell was deterred by this experience from adventurous ascents. Glaisher's descriptions are worth studying in detail by anyone who is interested in such fundamental questions as how rain and snow and hail are formed in the atmosphere. We learn, for instance, that rain can be falling at one level while there are swarms of snow crystals at a lower level.

More modern methods of exploring the atmosphere will not provide opportunities for such rapid but intimate examinations of the structure of clouds as Glaisher carried out. Since that time the use of manned balloons for upper air research has been confined almost entirely to Germany. Perhaps the best known result of German research is the formula given by Suring (the hero, with Berson, of the highest balloon ascent before Piccard's), for

the average quantity of water vapour in the atmosphere at all heights.

It was not until 1893 that the advantage of sending up balloons just capable of carrying the necessary instruments for recording temperature and pressure was seen. The first soundings were made in France, and it is to Teisserenc de Bort that we owe the discovery of the stratosphere or isothermal region which is to be found at a height of about thirty thousand feet. An explanation was soon found in the laws of radiation.

It seems to me unfortunate that the existence of the stratosphere was not foretold by theorists and verified by exploration. The discovery would have been a parallel to Einstein's discovery of the deflection of light by gravitation. The opportunity was missed, however, and history repeated itself in 1923 when Lindemann and Dobson were led by their work on meteors to the discovery of the high temperature of the atmosphere at 60 kilometres and upwards and *then* saw that the high temperature was a necessary result of the absorption of ultra-violet light by ozone.



PROFESSOR PICCARD'S FLIGHT.

In striking contrast with the picture on the facing page, this photograph shows Professor Piccard and his assistant testing instruments in the cabin of their balloon before the flight.

Balloon soundings are now made regularly by international arrangements so that the structure of the atmosphere over large areas may be studied. It is only when the collected data for a few days are examined that the complexity of modern three-dimensional meteorology is realized. In addition to the data derived from the instrumental records of the balloon soundings we have information obtained by aeroplanes, kites and captive balloons, the observations from the ground of the small balloons, known as pilot balloons, which are used to determine the strength of the wind and observations of the clouds which are themselves witnesses of the processes in action in the atmosphere. It must be admitted that the multitude of observations is overwhelming and that there is a good deal to be said in favour of Sir Arthur Schuster's plea that meteorologists should give up observations and retire to their studies to digest the existing records.

In the early days of scientific ballooning, electrical experiments were usually on the programme but little came of the observations. It is interesting, however, to recall the experiments of Professor Robertson who, with a companion named Lhoest, made on 18th July, 1803, one of the first scientific ascents. At a height of 24,000 feet Robertson electrified glass and sealing wax by friction, but these substances gave no signs of electricity which could be communicated to other bodies. A voltaic battery of sixty couples, silver-zinc, produced only five-sixths of the action on the electrometer which it had produced on the ground. I cannot explain these effects: the higher conductivity of the air does not seem to provide an adequate explanation nor does the condensation of moisture on the apparatus.

At the same height Robertson was not able to extract any electricity from the "atmospheric condenser." We should say now that the potential gradient was so low that the charge induced on a plate was too small to be measured by his electrometer. It was only in ascending and descending through clouds that Robertson was able to obtain positive electricity. What this means is uncertain, but it may imply that the conductivity of the air is low in cloud as compared with the free air. This is indeed the case.

It was not until late in the nineteenth century that electrical observations of any permanent value were obtained in balloons. It is well known that the ground is usually charged with negative electricity; one way of regarding the matter is to say that the air is positively charged and that a negative charge is induced on the ground. As a general rule the charge on the ground is not measured directly; it is easier to measure the potential gradient, which is proportional to the charge and is of the order of 200 volts per metre. To an observer with one quarter of the positively charged air below him, the net charge below him on

earth and ground is reduced by 25 per cent and so is the potential gradient at his level. It will be seen that observations of potential gradient in a balloon will yield information as to the distribution of electric charges in the atmosphere. Such observations are not very easy to arrange. One of the difficulties is that the balloon is apt to acquire a considerable charge itself and it is necessary to provide means for keeping it at the potential of the air in which it floats.

Measuring Potential Gradient.

Measurements of potential gradient have been made in balloons up to a height of nine kilometres. The gradient falls off rapidly, most of the positive charge being in the lower strata. At a height of four kilometres the gradient is of the order ten volts per metre. Apparatus attached to a sounding balloon has been used by Monsieur Idrac of the Trappes Observatory for recording potential gradient. His balloons have been recovered after ascending to 19 kilometres, at which level the gradient is only a fraction of a volt per metre. Observations of potential gradient in the lower atmosphere have been made with success in an airship; suitable apparatus for the purpose has been devised by Professor Wigand of Hamburg. His records of the potential gradient in the neighbourhood of clouds are of special interest. The efficiency of the air as a conductor of electricity has been measured frequently in balloons, mostly in Germany. It is found that conductivity increases with height. At nine kilometres Wigand found the conductivity twenty times as great as near the ground.

The facts that, at greater heights, a decrease of potential gradient and an increase of conductivity both occur are related. The strength of an electric current depends on voltage and conductivity. In this case the current in question is the " air-earth current " which flows from the atmosphere into the ground, and the evidence is clear that in fine weather this current is of the same average strength right through the parts of the atmosphere accessible to manned balloons. The problem how this current is maintained is of great interest. Personally I regard as adequate the simple theory, due to Professor C. T. R. Wilson, that this fine weather current is fed by upward currents in the neighbourhood of thunderstorms, the electricity from one part of the earth passing to another via the Heaviside Layer in the upper atmosphere in which the air is a very good conductor. We are not concerned now with the Heaviside Layer, which is out of reach of balloons, but we can ask what light do observations in balloons throw on the question why the air is a much better conductor of electricity at heights of a few kilometres than near the ground.

The observations which led to the answer to this question began with the study of the conductivity of the air in closed vessels. When X-rays and the Becquerel rays from uranium were discovered it was demonstrated that these rays could make air into a conductor, and the theory was developed that the air through which the rays passed was " ionized." The air contains ions, particles of molecular dimensions carrying electric charges; these charges move under the influence of an electric field and neutralize the charges of opposite sign on bodies with which they come in contact. It was an obvious extension of this theory to suggest that ordinary air is to a certain extent a conductor because it contains a certain number of ions. If the air in a closed vessel remains a conductor in spite of the neutralizing influences, the combination of the ions themselves and the loss of charge to the walls of the vessel, there must be some influence renewing the ions. As the rate of formation of ions is affected by screening the vessel by walls of heavy metals the ionizing influence must come from outside. It is, in fact, a " penetrating radiation."

It was soon found that the penetrating radiation was greater at great elevations than on the plains, and then observations were made in balloons. The critical ascents were made by Hess in 1911 and 1912 and by Kolhörster in 1913 and 1914. There is a decrease of penetrating radiation in the first kilometre. This is explained by the fact that some of the radiation is due to the radium emanation in the air; the emanation having come from the ground does not diffuse to great heights. Beyond the first kilometre the penetrating radiation increases steadily. At five kilometres, the greatest height reached by Hess, the excess is sufficient to produce sixteen ions per second in each cubic centimetre of air. At 9.3 kilometres, the height reached by Kolhörster, the excess was eighty-five ions per second per cubic centimetre.

Radiation from Above.

The natural conclusion that the penetrating radiation comes from above has been substantiated by numerous researches. It has been found by eliminating the effects of the radiation from radioactive matter in the air that the " cosmic radiation " from above is reduced at the ground to such a strength that it produces only one ion per second per cubic centimetre. It will be seen that the " cosmic radiation " accounts for the high conductivity of the free atmosphere at the greatest heights reached by balloons.

During the last few years there have been numerous

investigations of cosmic radiation. It is found that the strength of the radiation at a given level is practically the same at all times of day and in all parts of the world. The possibility that the radiation originates at a great height in our own atmosphere must not be excluded, but practically all investigators agree with the view that the radiation comes from outer space. There is some evidence that about one half per cent comes from the sun. Attempts to demonstrate that more comes from the Milky Way or from great nebulae than from other parts of the sky have not been conclusive up to the present.

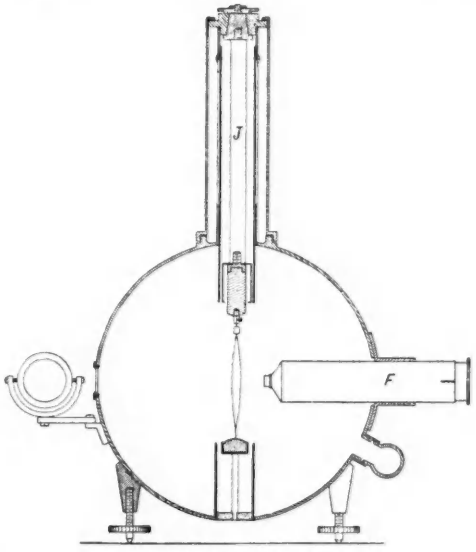
Two Components.

The great penetrating power of the cosmic radiation has been demonstrated most thoroughly by Professor Regener, who has lowered his recording electrometer to a depth of 240 metres below the surface of Lake Constance. The analysis of Regener's results shows that there are at least two components in the radiation. The more penetrating component is such that a thickness of thirty-five metres of water is necessary to reduce the strength by one half. The projectiles of which the radiation consists must have more energy than any others with which physics is concerned. As sources of this energy very fundamental processes have been suggested. Jeans favours the annihilation of matter by the mutual destruction of positive and negative electricity, protons and electrons. Other physicists look to the reduction of the nuclei of atoms to their constituents, electrons and protons. We may say that the subject has been taken out of the hands of meteorologists and has become the concern of astronomers and pure physicists.

The meteorologist has a watching brief, however, for we do not know what part the penetrating radiation may play in such every-day processes as the formation of cloud. Schonland has demonstrated that the radiation is stopped to a certain extent by a thunder-cloud. It is possible, though not likely, that the electrification of the clouds is induced in some way by the radiation; it is not likely for, as C. T. R. Wilson has stated, the total energy of all the thunder-clouds in action at any instant is about one hundred thousand times as great as that necessary to maintain the supply of penetrating radiation reaching the earth's surface.

While the experiments of Regener indicate the nature of the "hardest" component of the penetrating radiation, it is possible that there are "soft" components which are eliminated at great heights in the atmosphere. The search for such components would seem to have been the stimulus for Piccard's heroic ascent. What apparatus he carried has not been stated in the popular accounts of his voyage. The apparatus devised by Kolhörster would have served. The electrometer incorporated in this apparatus is very simple, a couple of loops of silvered quartz fibre fixed to the tube of a microscope by means of a bent quartz tube. The ionization chamber is airtight so that it may be filled with gas at high pressure.

It would have been asking too much of a pioneer to expect Piccard to investigate not only the penetrating radiation but also the conductivity of the free air and the potential gradient. Apparatus for recording these elements might have been fixed outside his car. The results would have been valuable



WULF'S APPARATUS.

The gap between two quartz fibres is observed with the microscope F. As electricity leaks away, the fibres approach each other. The apparatus is watertight, so the penetrating radiation may be measured under water.

as a contribution to the study of the circulation of atmospheric electricity, for we want to be sure that the air-earth current persists as a vertical current up to great heights and is not diverted, as Wigand believes, at the level of the highest clouds.

No doubt the sporting spirit will lead many to emulate Piccard's feat.* There are many problems of the high atmosphere which might conceivably be solved by observations at great elevations; it is, however, in atmospheric electricity that the opportunities for useful research are most obvious. Let us hope that the opportunities will not be missed.

*It is a curious coincidence that Piccard's life, like Glaisher's, was jeopardised by the failure of the valve gear. The lesson that duplicate gear should be provided must be emphasized.

South America: (5) An Argentine Estancia.

By John A. Benn.

In this extract from his South American diary Mr. Benn describes a visit to an estancia on the Bovril company's Argentine estates. During the "summer" months from January to June, nearly one hundred thousand cattle are dealt with both for extract and meat canning purposes by this company alone.

AT the invitation of Lord Luke, chairman of Bovril, Ltd., my wife and I were able to visit the company's Argentine estates in Entre Rios. As its name indicates, this province lies between the Parana and Uruguay Rivers, where vast areas are devoted to cattle raising. Unlike the flat plains which characterize Argentina generally, Entre Rios is an undulating country, threaded by rivers which make it rich and fertile. On a bigger scale, the landscape would resemble Sussex, if the hills of Sussex were ironed out a little and stripped of their profuse woods.

Our goal was Santa Elena, the small town on the Parana which has grown up round the Bovril factory. There is no direct route from Buenos Aires except by steamer, which takes rather longer than the trains but gives a wonderful impression of the great rivers that flow into the River Plate. The Uruguay and Parana are navigable everywhere in Argentina and ships of 10,000 tons can steam as far as Rosario, over three hundred miles from the sea. At Buenos Aires the River Plate is fifty miles wide and after two days' sailing the Parana is still several miles in width, broken by large islands. The course of the Parana is continually changing, and the country is flooded for miles on either side during the winter. At times the steamer passes within a stone's throw of the bank; a few minutes later it is on a stretch of water ten miles wide. There are flags to show the channel, and the huts occasionally seen on the islands are built on poles high above the water.

Near Rosario the river becomes more defined and there are grain dumps and factories on the banks. This town is the second largest in Argentina and is the natural port of the north-western area. The quays are crowded with ocean-going steamers which carry their cargoes of grain and frozen meat direct to Europe. Another port a hundred miles higher up the river is likely to compete in importance with Rosario in the near future, namely, Diamente. This town is now being connected by rail with the grain areas, and modern quays have been built to accommodate large steamers. The next port is Parana, where the towers of the Spanish cathedral stand out in the flat landscape. It is nearly four hundred miles from Buenos Aires and for a brief period (1853-1862) was the capital of the Republic.

THE BOVRIL FACTORY.

Behind the white-roofed factory the village is built on a hill which rises gradually from the water's edge. It is the gateway to the Bovril estates in this part

The river resumes its wild appearance before reaching Santa Elena. This village is in striking contrast with the previous ports, where the houses are hidden from view by the high banks of the river. Behind the white-roofed factory the village is built on a hill which rises gradually from the water's edge. It belongs to the Bovril company and forms the gateway to their estates in this part of the country. The Bovril estates cover one and a half million acres in the Argentine and eight and a half million acres in Australia, in all an area about the size of Wales. The estancia on which I stayed near Santa Elena was comparatively small, covering a mere fifty thousand acres!

The roads in Entre Rios are good of their kind but consist of beaten earth, as stone does not occur naturally in this part of Argentina. Our arrival coincided with heavy rain which made them impassable for two days. Even when the sun had dried the

surface, the car which took us to "El Quebracho" was fitted with chains to prevent skidding. The roads are ploughed up and arced at the centre by road machines of the North American type, the object being to allow the rain to run off. When the roads are dry they make excellent motoring and it is possible to cover the thirty-one miles from the factory to the small town of Bovril in less than an hour. At "El Quebracho," which is nine miles from the river, the cattle are collected from the surrounding country before being sent to the factory. The manager's house is protected by a plantation of shady trees, as is customary on estancias throughout Argentina. This part of the country is wooded with rather stunted trees, and it has none of the barren appearance of the vast plains in the west.

The seasons in South America are, of course, reversed, and production on the cattle estancias is carried out in the summer months from January to June. The factory is unable to get fat cattle until January, but the freezing works in the south draw fat cattle during the winter from the Province of Buenos Aires and Cordoba and from several Alfalfa camps. Even the freezers, however, have to pay higher prices in the winter months as there is naturally a scarcity of fat cattle. During the summer nearly one hundred thousand cattle are dealt with by the Bovril company alone, both for extract and meat canning purposes. To satisfy this enormous demand, even larger numbers are constantly being bred and pastured, so that the industry contributes on a large scale to the agricultural prosperity of Argentina.

Size is the predominant feature of an Argentine estancia. To get an idea of the scale on which cattle farming is conducted one might stand on the south downs—perhaps near Steyning—and imagine the country, as far as the eye can see, devoted to cattle. An area even of this size would not exhaust the boundaries of a single estancia. Our host at El Quebracho thought very little of driving fifty miles to inspect some cattle, and before the advent of cars it was often necessary to ride across country for days at a time.

The cattle are handled on the same large scale. The whole countryside is fenced into paddocks, but some of them are five hundred acres in size and it requires an afternoon's work to round up the cattle in a single enclosure. The most striking impression is the care with which the animals are handled. One might suppose that special attention was unnecessary a few days before slaughter, but exactly the opposite is the case, thus ensuring the best results both in meat and by-products. For this purpose the new motor barges are equipped with fans and showers for keeping the cattle cool and plenty of drinking water is provided. Trooping cattle soon lose their weight unless special care is taken, while bumping in the train bruises the meat. For this reason the man in charge of the troop generally tips the engine driver provided he pulls up at the stations without jerking. On the big scale, it is possible to use all the products, such as bones and hair, which are usually wasted.

Our most interesting day was spent in following a troop of two thousand cattle—Argentines do not speak of "herds." This troop consisted of cows and calves which were being driven to the "dip," and as nearly every calf became separated from its mother, there was a constant bellowing and moaning. Ten

CROSSING A RIVER.

A picturesque scene was afforded when the cattle had to cross a river. Jostling and bumping each other, they made quite a commotion in the water before emerging.

ONE OF THE PEONS.

One of the native peons is seen in the foreground. They love bright colours and dress in blue and orange shirts with scarves of a different colour.

peons were in charge of this troop. The Correntinos and Entrerianos in this part of Argentina show a strong mixture of Indian blood and many of them have distinctly Indian features, being short with very dark skin. They love bright colours and dress in blue, orange and striped shirts, with scarfs of a different shade. They always carry long knives, which find constant use in connexion with their horses or cattle, and are often brandished in a quarrel. The peons are excellent workers but have an excitable temperament, for which reason their hut-dwellings are usually built as far apart as possible. Riding is second nature to them and during the busy season they spend the whole day in the saddle, from dawn until late at night.

The animals slowly progressed as an enormous jostling mass, but a few of the bolder calves on the edge of the troop tried to break away. Usually the attempt would be baulked but sometimes a fast youngster would go careering away, giving the peon a good gallop before it was brought back to the troop. After some miles the cattle were halted for rest and to treat a few cows for hide infection. It is one of the marvels of the peon's craft that he can pick out an animal infected in this way from among such enormous numbers. Earlier in the day on leaving the paddock the troop was counted, and no doubt the infected animals were noted. But to single them out some hours later among two thousand cattle seemed an almost impossible task.

After three or four horsemen have been posted at the outskirts of the troop, the foreman rides among the cattle to lassoe a "patient." He may be lucky and secure a capture at the first throw; more likely, the cow resents the attempt and tries to hide among the other animals. When eventually caught round the neck, she is pulled away from the troop and another peon lassoes her hind legs. Then, sitting on the animal's head, two men remove the insect from the hide and treat the wound with a disinfectant lotion. Away the cow charges, bellowing at this indignity but a more healthy and comfortable animal.

A picturesque scene was afforded when the cattle had to cross a river. At this time of year the water is not deep and the animals plunged their way across without having to swim. But jostling and bumping each other, they made quite a commotion in the water before emerging on the other side and filing up the bank. Meanwhile, the peons rode their horses through the water, encouraging the cattle with shouts and by waving the aprons of their saddles. It is exceptional for a peon to whip the cattle he is driving, but he keeps up constant whistling and a "ttss-ttss" which is most effective. When the water is deep and the cattle have to swim across, two decoy oxen are sent over first and the rest of the cattle follow. There is generally a canoe nearby in which the peons travel over with their saddle equipment, the horses swimming behind. At the same time, the peons are very strong swimmers and often swim by the side of their horses.

LASSOEING A "PATIENT."

Picking out the infected animals for treatment is one of the marvels of the peon's craft. The foreman rides among the cattle to lassoe a "patient."

The native saddle consists of a sheepskin and a blanket, bound round with a leather girth strap, the stirrups being made like rings, without any shaping for the foot. The saddle is, in fact, a complete camping equipment and forms the peon's "tools." Nearly every native possesses his own saddle and horse, and these are the last things he will part with. Riding across country in search of work, he is completely self-supporting as long as he has a horse and saddle. Judged by English standards, horses are dirt cheap in Argentina, although they are not native to the

country but were introduced by the early settlers from Spain.

It is safe to say that horses will be used on the *pampas* for years to come, although the motor-car is taking their place for many purposes. In winter the roads are impassable except on horseback, but in summer cars are used on both the roads and fields. To be driven for miles across rough grass and even ploughed land is an amazing experience after motoring in England, especially when the driver thinks nothing of running over shrubs as large as gooseberry bushes. One hears a good deal about the performance of American cars under conditions of this kind, and at present they have almost a monopoly in Argentina; but I was interested to see a Morris-Oxford that was still running well after 93,000 kilometres—twice the average life of the American cars, which are usually replaced after 50,000 kilometres. The reason why the American car is so predominant appears to be that while it lasts it is particularly suited to the country and there are excellent spare parts services.

TREATING AN INFECTED COW.

When eventually caught the infected cow's hind legs are lassoed, and two men sit on the head while they remove the insect and disinfect the wound.

During the summer, when insects do a lot of damage, the cattle are "dipped" about once a month. This process is carried out in a long narrow bath built of concrete, through which the animals are made to swim. The bath adjoins a small fenced *corral*, where they are collected and then released in single file through a narrow fence. A sudden slope plunges each animal into the arsenic dip, and if it does not wet its head, a "ducking" is administered by the peons. A man stands on either side of the bath with a forked pole (like a big clothes prop) and applies the fork to the neck, forcing the head under water. This precaution is necessary so as to cleanse the whole hide. On one occasion recently a pole broke and the peon followed the cow head first into the bath! Clinging to the tail of the animal, he was towed through the bath and emerged safely at the other end.

The Bovril company breeds large numbers of beef shorthorn cattle besides buying them from local estancieros. Their principal breeding centre in Entre Rios is the estancia known as Vischacheras, where the prize champion shorthorn bull of Argentina is at present kept. This magnificent animal lives in great luxury, with fly-proof windows to its stable and having its temperature taken daily. This bull was bought about three years ago and was champion of the year at the Palermo Show, which is the largest pedigree cattle show in the world. As much as £10,000 has been paid for the purchase of a Palermo champion bull. The most striking spectacle at Vischacheras was a troop of seventy bulls which have been trained to feed in special formation. A long trough of food is placed outside a small paddock, and when the gate is opened the bulls rush out to take their places along one side of the trough only. These magnificent animals form a perfect line, their heads lowered to the food, just as if they were doing a circus turn! One bull tried to step over the trough while we were watching this performance, but quickly resumed his place on a threat from the peon in charge.

Cattle bred in other parts of the country are brought to Santa Elena by river. During the past year the Bovril company has introduced a new type of barge which embodies many improvements. The barge has three storeys on which altogether seven hundred cattle are carried, and an elaborate spraying system provides the animals with a shower-bath during hot

THE DIPPING BATH.

During the summer when insects do a lot of damage the cattle are dipped about once a month. This process is carried out in a long bath built of concrete.

weather. This arrangement not only adds to their comfort but ensures that they reach the factory in much better condition than would otherwise be the case. The new barges are fitted with engines and are self-contained; the old type had to be towed by tugs and were consequently less mobile, besides making slower speeds. We passed several cattle barges on our journey up the river, most of them taking cattle to the frigorificos near Rosario.

Weighing the Cattle.

Before going to the factory the cattle are weighed and finally inspected. To weigh them single would be a slow and difficult task, and an ingenious method is used. The animals are driven in batches into a weighing shed, which is closed either end by gates. The floor of the shed is a large platform, and when the shed is full to capacity, the load is determined in the weighing room adjoining. About seventy animals are weighed at a time and the scale is turned at about thirty tons, the machine being sufficiently accurate to show the load to the nearest kilo. Then the gate at the exit end is opened and as the animals rush out of the shed, their number is counted. The Argentine Government inspects all the cattle that are destined for the meat factories throughout the country. Rigid standards are maintained and sometimes hundreds of cattle have to be destroyed, although a case of rejection is very rare on the Bovril estancias.

Cleanliness in the factory and meat works is always maintained at a high standard. One of the main reasons for using fuel oil for firing the boilers at Santa Elena is that in the old days the coal dust blew about, and when some ten to fifteen thousand tons of coal were being landed during a windy period it took some time to rid the factory of the refuse. Now the oil tanker comes alongside and despatches the fuel, and the place is left spotlessly clean.

Once the animals have passed through the slaughter house, a series of processes begins for obtaining meat extract and preparing the meat for canning. The factory is the most modern of its kind in Argentina, as every year improvements are introduced to cope with the growing demand for its products. All the workmen are provided with white aprons and caps, and in watching this up-to-date factory the visitor might think he were at Birmingham, instead of isolated in the country more than a hundred miles from a city. Most of the workmen have never been away from Entre Rios, and although expert in handling the machinery, they would feel quite lost if suddenly transported to an English industrial town. The village of Santa Elena houses 5,000 people and 1,500 are employed in the factory. The Bovril company supplies a store and also an hotel—appropriately called Hotel Progress—where buyers come from miles around. A travelling photographer was doing good business outside the hotel the day we were there, taking pictures of the peons who ride into the village from the surrounding country to buy their stores.

The chief products of the country are canned beef and meat extract, the latter being shipped to England for preparation into Bovril. The by-products of cattle are much more numerous than is generally realized. Hides and horns are important items in the list; bones are exported to Japan for button manufacture; gall is used in printer's ink and dyestuffs; sinews are made into chewing gum and high-class lacquer. In addition to tallow and edible fats, there are animal foods made from entrails and liver. "Tankage" is used as a fruit fertilizer, and bone meal is another agricultural product. Neatsfoot oil finds a market for tanning and also in watch-making. Finally, there is the tail hair which is sold for upholstery.

All the tins and packages used at Santa Elena are made in the factory. At the time of our visit the machines were turning out 60,000 tins per day, about 10,000 being for six-pound packages and the rest of twelve-ounce size. These figures give some idea of the enormous production of meat in Argentina. Bovril, Ltd., is, of course, only one of the many companies engaged in meat canning and there are eighteen meat-freezing plants in Argentina. The present output of meat, for which England is the biggest customer, by no means exhausts the capacity of the country.

Scope for Development.

There is still scope for development and already new colonies of immigrants are settling in Entre Rios under the auspices of the government and of private land-owners. Owing to the plentiful water supply, the soil does not require the irrigation or special treatment necessary elsewhere, and the luxuriant grasses can support enormous numbers of cattle. Dairy and poultry farming has recently been extended in this province, while agriculture is developing with the aid of mechanical plant. A new type of motor plough, invented by an Australian, is now being tried out on the Bovril company's estates, where large quantities of maize and other cattle food are grown.

Since 1900 the population of Argentina has trebled, the latest figure being 11,000,000, and it is estimated that the country can support 25,000,000. It needs little imagination to foresee that the country offers enormous scope for further development.

The Tombs of the Sacred Bulls.

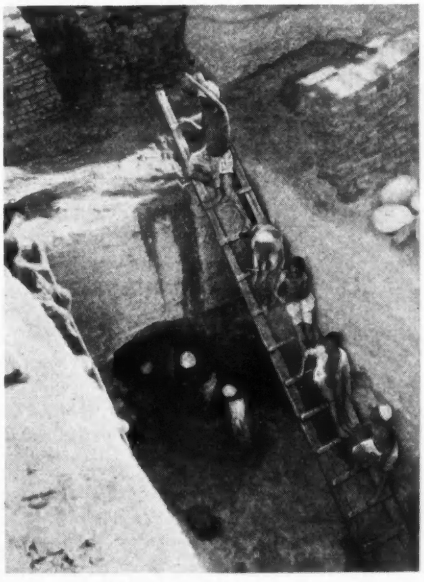
By O. H. Myers.
Egypt Exploration Society.

Recent work by the Egypt Exploration Society on the burial place of the sacred bulls has enabled archaeologists to arrive at the dating of the tombs, and thus to assign most of the animals to the rulers who inducted them. It is hoped that further excavation will reveal the residence of the bulls during their lifetime.

PARADOXICALLY, the greatest enemy of excavations in the desert of Egypt is often water, and this in a place where it rains once in every ten years. The water comes from below and is not so unpleasant for the archaeologist as rain, but may be just as damaging to the *antikas*. The Nile water level extends under the low desert beyond the edges of the cultivation, and as the Nile rises and falls with the floods, the water level rises and falls too. Unfortunately for us the level of the Nile rises year by year as the silt is laid down on the cultivation, and tombs cut in land which at that time remained dry, even during the flood, are now often under water all the year round.

There are few things more trying to the excavator than finding that he has to work under water-level. On the other hand, nothing is more pleasing to the *fellahin* children upon whom he relies for much of his labour. This difficulty was encountered in attempting to excavate one of the impressive series of tombs forming the Bucheum, or burial place of the sacred bull Buchis, on which the Egypt Exploration Society, with the generous help of Dr. Robert Mond, has been at work at Armant, near Luxor. Though similar to the Serapeum in purpose and layout, the Bucheum was a poorer site because it was functioning during a period (XXXth Dynasty to the Emperor Diocletian) when Thebes was no longer the capital.

Near the Bucheum is the Baqaria, or burial place of the mothers of Buchis, which we also excavated fully and, although altogether twenty burials were completely or partially submerged, it was only in one case that we were unable to clear it. There we had two *shaddufs* working a pump and a chain of buckets. With these we found that we could lower the water two metres, after which it held its level, and as we found that the bottom was two metres under water we were obliged to leave the tomb until someone can afford to bring a steam pump to the site. Even if it is possible to pump a tomb more or less dry the filling has to be taken out in mud form. If this is left to dry there is always the danger of its forming into a hard, brick-like cake, so we found it best to "wet-sieve" it. In this case the most skilled children sit on planks placed across a pond formed by the water runaway and dip the sieves in and out of the water. It is then easy to pick out the beads and other objects from the residue. In this way the entire contents of the tomb were sieved, with no possibility of objects being left behind.

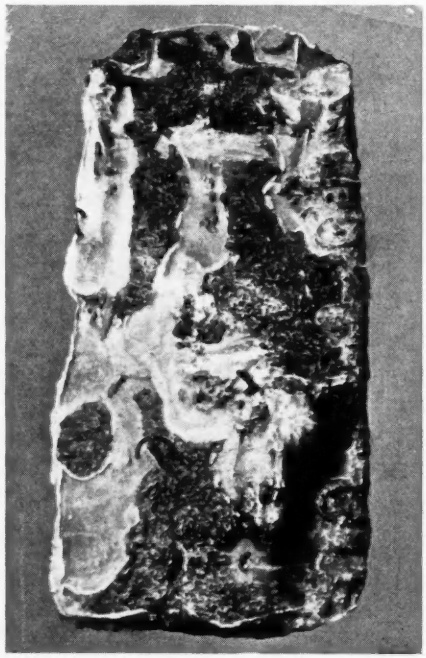


EMPTYING A FLOODED TOMB.

The greatest handicap to the excavator is often water, but nothing is more pleasing to the native children who assist him.

Excavating the remains of a cow involved a somewhat different problem. We were anxious to preserve all whole bones which might be of interest to osteologists. Here the water level was just below the surface of the ground. Each bone was left upon a column of earth about four inches high, and it was in this way that the bones were induced to dry out sufficiently for cleaning and treatment. There were occasions, however, when there was not time to let an object dry before it was necessary to clear the ground for further operations. This was so in the case of a slab of sandstone inscribed in Demotic. In its wet condition

it combined great weight with the consistency of damp blotting paper. Here boiling paraffin wax, one of an archaeologist's greatest allies, was called into play. It is perhaps not generally known that objects which are sodden with water can be waxed to a certain depth. It is necessary to get the wax as near to combustion point as possible and to use immense quantities regardless of how much pours off. Of course, if there is any means of heating the object beforehand—such as with a blow lamp—it is a great help. After we had driven the wax as far as possible into the surface, we continued to pour until the whole stone was coated with cool wax. When quite cold the stone was raised and taken to the house, where it was left to dry upside down in the sun. When dry the separate pieces were cleaned and boiled in wax so that the stone was strengthened without any traces of wax appearing on the surface.



WAXING A COW MUMMY.
This was the biggest waxing job ever undertaken. In the course of the work many improvements were made in technique.

But by far the biggest job of this kind we had to undertake was the waxing complete of two cow mummies which, as far as I know, is the biggest attempt at waxing ever undertaken, the nearest approach being Mr. Woolley's bodies from Ur. To undertake this we had to purchase half a ton of paraffin wax, a large cauldron, three sacks of cotton, a syringe and a variety of miscellaneous tools. In the course of this operation we made a number of improvements in technique. We discovered that three temperatures of wax were needed. First, we needed the hottest possible to penetrate into the very materials themselves—the linen, skin, wood and bone—a moderately hot wax to fill in the pores in the materials, and wax that was on the point of setting to fill all the large cavities and to saturate the cotton. This was largely used for building up the shallow parts of the mummy in order to produce a block of sufficiently uniform strength to support its own length of three metres. One of the great problems in waxing a large fragile object is that, in order to make the wax penetrate to a great depth, it is essential to pour in pot after pot; during this operation the surface is likely to be washed away. This is especially so upon a slope, such as the neck and shoulders of a cow mummy. To overcome this difficulty we drove the wax right down through the top of the head (by boring holes with a brace-and-bit and pouring in very hot wax) and then syringed the sides, regulating the stream so that it penetrated and did not run off the linen and skin. With a syringe it is also possible to wax vertically upwards. It should be explained that the hottest wax will not fill even the interstices in linen but will only strengthen the threads. The large cauldron, heated by a giant primus, kept the wax at the middle temperature. From this wax was drawn in a smaller receptacle and heated or cooled as required.

To build up the cotton packing we made retaining walls of "putty wax" and placed the soaked cotton in the cavities thus formed. Putty wax is made by pouring hot wax into cold water; it remains malleable but not sticky for an hour or more, but afterwards sets hard. In building up this padding we were fortunate in being able to turn an electric fan on to the outside so as to prevent the warm wax from bursting its bonds. In preparing the mummy we cleaned the body of all wrappings and skin and preserved it in skeleton form together with the wooden bier, the wooden pillow and the bronze staples which fastened the mummy to the bier. One of the mummies is coming to London and will be unwaxed with a blowlamp before being exhibited in September at the Welcome Historical Museum.

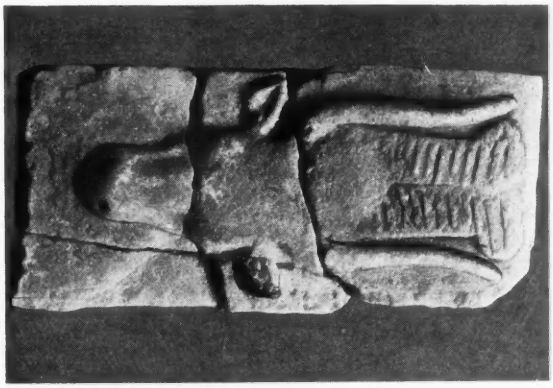
Many complications arise in the excavation of an underground system in use for a period of seven hundred years. During this period there were at least two serious collapses of roof, with consequent restorations, many more minor changes and patchings, as well as constant additions. The periods are very difficult to separate. In an above-ground series it is an almost invariable rule that the earlier phases underlie the later, but underground this is not by

any means always the case. The funerary stela, or tombstone, of a bull, buried in the reign of Ptolemy Epiphanes, was recovered in magnificent condition the season before last. More recent excavation shows that the stela was raised at a later period of reconstruction, the original entrance to the tomb being 50 cms. below the base of the wall. There was some very fragmentary pottery at approximately the level of the bottom of the wall. Had we not excavated down to native rock we should have assumed that this pottery, which contained burnt offerings to Buchis, was contemporary with the stela and have dated it thus. It is now shown to be later offerings made at, or after, the replacing of the stela and the building of the mud brick wall.

In the Bucheum, numerous stelae, some of them *in situ*, gave us points for the dating of the different tombs from which we have been able to assign most of the bulls to the rulers who inducted them. In the Baqaria, however, where only one stela was found, we were obliged to work on other data. We made a *corpus** of all the bronze staples in the hope that these might assist us, but we found little evidence from this source. A certain amount of pottery was not without value, but unfortunately the sequence of the Graeco-Roman pottery is little understood. We had then to fall back upon the walls blocking the entrances to the burials and to the arched vaults that cover the Roman cows. Here a very careful cataloguing of the bonding of the walls, the sizes of the bricks and the thickness of the interstices has enabled us to discover for the major part the order of the different burials. Given, as we are by the Bucheum, a starting and a finishing point, we can now discover which bulls the different cows had the good fortune to produce for the benefit of a credulous people.

TO A SACRED COW.

This illustration shows the only inscribed tombstone ever found erected to one of the mothers of the bulls. It belongs to the period of the reign of the Emperor Commodus.



TOMBSTONE OF A BULL.

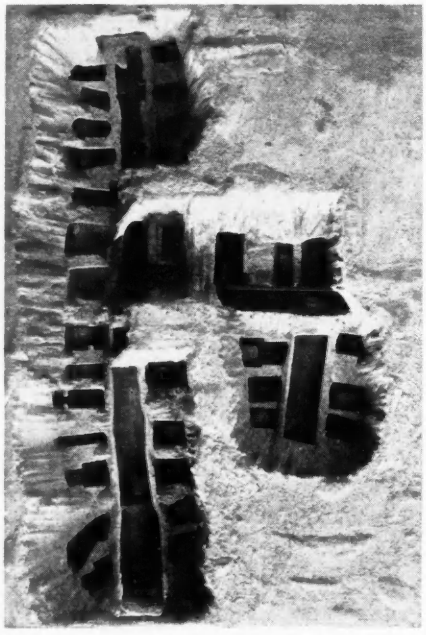
Numerous tombstones in the Bucheum provided data for purposes of dating, and thus enabled the excavators to assign the bulls to the rulers who inducted them.

The Bucheum itself is roughly T-shaped, the base of the T representing the entrance of a sloping ramp. Half-way down the ramp there are tombs on each side, but by far the greater number of burials lies along the cross passage. Knowing that some of the earliest burials were at a point where the cross passage cuts the entrance ramp, we began with the assumption that the builders gradually extended the passages as they needed space for new tombs. Had we considered the nature of the ground more carefully we would have seen at once that this was unlikely. The ground consists of a series of strata of varying strength, marls, sand and gravel, and the reason for the numerous collapses in later times was that the tombs were too close together. The earlier builders saw the danger and spaced their tombs well apart, and it was the later and lazier people who inserted their poor burials between the better work of their predecessors. The construction of the place typifies any piece of Egyptian enterprise. With a few exceptions any new thing in Egypt begins with a flourish of trumpets and then fitfully decays. In the Bucheum there are at first solid sarcophagi cut from one piece of stone, but from well-built sarcophagi built of neatly dressed and numbered blocks we proceed to those built of blocks that are hardly dressed

* Outline drawings arranged for handy reference and much used in the field for dating purposes.

at all, and finally finish with burials actually in the passage itself. The same trait is noticeable throughout Egypt. Amulets are at first beautifully modelled, but they degenerate into a formless lump of glaze with a hole through it.

There are, of course, always periods of revival, such as the well-known Saitic period when there was a wave of interest in archaeology and the artists, influenced by archaic models, produced masterpieces of their own as well as excellent imitations—or, for all we know, deliberate fakes! Because of these sporadic outbursts of energy we have to guard ourselves from calculating upon a degradation of form following a steady course of depravity from reign to reign. At certain periods new forms may come in which, while inferior in conception to those that preceded them, may yet be superior in execution to the degraded copies to which the predecessor has sunk. For example, a brick building is not *per se* as fine as a stone one, but an individual brick building, well planned and executed, may be far superior to a stone one in which the builders have more and more feebly copied their forerunners' work without original artistic perception or craftsmanship.



A MODEL OF THE BUCHEUM

This model of the tomb of the sacred bulls has been constructed so as to give the onlooker the most comprehensive view possible.

Little imagination is required to see that the planning of such a complex as this is no easy matter. Even when the different periods are clear in the mind of the surveyor, he has still the difficulty of showing them on paper in such a way as to be intelligible to one who has never seen the site, without requiring too much hard work on the part of the reader. As a help to us in working this out, and as a much fuller reproduction than can be given two-dimensionally, we have had a three-dimensional model of the Bucheum made. This model is partly reconstructional and shows the place as it was in the Roman period cut into so as to give the onlooker the most comprehensive view possible. As yet the residence of the bulls during lifetime has not been uncovered, but this is not surprising as, according to Macrobius, the bull was worshipped in the Temple of the Sun at Hermonthis, Armant, and we have not yet investigated that town site. We had hoped, however, to discover a funerary temple near the Bucheum itself, but if this ever existed it has completely disappeared. When we first found a village site near the Baqaria we anticipated that this would contain the temple, but unfortunately it was proved by the coins to be only the village in which the robbers of both sites lived during the beginning of the Christian period.

In spite of this disappointment we gained valuable evidence from a series of stelae extending, with one or two breaks, from the time of King Darius III to that of the Emperor Diocletian. In these funerary stelae the priests administered to their vanity, or perhaps rather that of their religion, by alleging a personal interest in Buchis on the part of all the rulers, including the Roman emperors. They state that Cleopatra VI herself brought the bull up the river from Karnak for his induction — a possible but unlikely happening. From the point of view of obtaining objects the site has proved a little disappointing. Apart from the stelae very few objects of great intrinsic value have been obtained. Last season we found in the tip-heaps, made during the original excavation of the site by the ancient Egyptians, a fine Nemes vase in green faience inscribed "Beloved of Osiris Buchis the King Nekht-Hor-Heb." This has been retained by the Cairo Museum. From the same source we recovered a fine group of bronzes, including two inscribed situlae and a Kebeh vase, which are coming to England. A fine set of stone and faience amulets have also been discovered and a good *corpus* of pottery constructed.

Although the Bucheum and Baqaria are finished, there still remain many years' work to be done on the Society's concession upon sites ranging from Predynastic settlements to Coptic monasteries. Although these may not be as spectacular as the excavation of the cemetery of a god, they are likely to prove as interesting scientifically and much more productive of museum objects.

An Emperor's Footnote to Ancient History.

By R. S. Conway, Litt.D., D.Litt., F.B.A.

A passage for which Livy has been criticized is now found to have been connected with a political question of his day. It is a note furnished him by Augustus, whom the historian makes solely responsible for its truth.

It appears to be one of the things which distinguish emperors and their like that they tend to be anxious what their reputation may be after they have gone. We ordinary people are probably a little more careful than an emperor about what our next-door neighbours may be thinking; but very few of us, happily, are worried as to what our reputation will be a hundred years hence; we know it will hardly exist.

This anxiety on the part of ruling persons sometimes shows itself in a rather amusing way. They like to win the esteem of people who write, especially if the writer is one whose work seems likely to last. We all know what an interest "our Good Queen Bess" took in Shakespeare's plays, and how at least one of them, "The Merry Wives," was written at her express command; and Vergil's "Aeneid," the great poem which the educated world has had so much in mind this year, the 2,000th anniversary of its author's birth, would have been destroyed as unfinished and imperfect by his own last command but that the Emperor Augustus intervened.

This recollection may make us a little indulgent in judging that particular emperor. But his relation to the writers of his time is often misunderstood, and the instance which we are to consider shows rather neatly the limits within which he was able to influence one of the greatest of them—the historian Livy; just as, conversely, the story which I discussed some five years ago in an article on "Livy as a Politician"* indicated the influence which Livy was exerting on the Emperor in the last year of his reign.

Livy's Attitude to Augustus.

Just about the same time Professor Gertrude Hirst of New York was discussing a story which has only recently come to light and will at least give us a little wholesome caution next time we have to read a royal autobiography, official reports, or the political columns of controlled newspapers.

An incident which Livy records in the early part of his History (Book IV, Chapter 20, which we know to have been written a year or two after 27 B.C.), shows that he was on friendly terms with Augustus. So much so that Augustus gave him to include in his History a kind of footnote, as we should call it, which called in question the accepted view of a certain ancient event and gave the Emperor's reason for denying it. Livy records the Imperial communication with evident pride; but if the passage be read with care it is clear that Livy abstains carefully from pronouncing a judgment of his own about the conflict of evidence. He is commenting on the story, which he has just related with great spirit, of a fight in the fifth century B.C. between a Roman called Aulus Cornelius Cossus and an Etruscan chief whom Cossus had slain in single combat, so winning what was called royal spoil, *spolia opima*, which the custom was to dedicate to Jupiter in a particular temple.

The Emperor's Footnote.

'I have followed all the authorities in relating that it was in the office of military tribune that Cossus won these spoils and dedicated them in the Temple of Jupiter Feretrius. But in the first place spoil is only properly called royal when it is taken by a Roman commander from the commander of the enemy; and we recognise no one as commander unless he is actually the general in charge of an army. Secondly, the actual inscription written upon the spoil itself goes to prove that both I and my authorities are wrong and that in truth Cossus took the spoil when he was Consul. This fact I learnt from Augustus Caesar, the second founder of every temple in Rome, since I heard him say that when he entered the shrine of Jupiter Feretrius, which he restored from an almost ruinous state, he read with his own eyes this inscription written on the linen corselet. And I feel that it would be almost a sacrilege to rob Cossus of such testimony to his achievement, the testimony of the Emperor himself, the second founder of the temple. But if the source of the confusion lie in the ancient authorities and the Books of Linen . . . which date the consulship of Cossus seven years later, that is a point on which every reader is free to use his own conjecture. For we cannot ascribe his famous combat to that later year, which falls in a period when pestilence and dearth of corn almost precluded war. . . .'

**Discovery*, November, 1926.

'But we may toss these matters of small importance to and fro, according to every man's opinion; seeing that when all is done, the author of this battle his own self, when he set up these fresh and new spoils in a holy place, in the sight of Jupiter himself standing thereby, to whom they were vowed, and Romulus also, two witnesses not to be despised nor insulted with a false inscription, wrote himself "A. Cornelius Cossus Consul."' Incidentally, the discerning reader may have scented in this concluding paragraph of the rendering a freshness hardly to be compassed in our own labouring day. It is taken almost completely from Philemon Holland's version which was dedicated to Queen Elizabeth in 1600.

A Long-standing Question.

But what possible importance for us, here and now, the reader may ask, can lie in this ancient and highly technical, not to say dusty and fusty question of the particular rank held by a doughty hero of the fifth century B.C.? Professors of history have sniffed and asked another question: Why did Livy merely tell us what Augustus read in the temple instead of going into the temple and just reading it for himself?

Professor Hirst has answered those questions. She points out that there are only three references to the Emperor in the part of Livy's History which we possess. The first is near the beginning, where Livy mentions with thankfulness, as 'a sight which the gods have granted to our own age when peace has been established on land and sea,' the closing of the Gates of Janus; that was the name given to a kind of double portico in the forum, surmounted by the head of the god Janus, of which the gates were always kept open in time of war. Livy tells us that the only occasions on which the gates had been known to be closed were, first in the reign of the half mythical king Numa, secondly at the end of the first Punic War (241 B.C.), and thirdly by the Emperor Augustus in his own time; this we know to have been in 27 B.C.

This first reference to Augustus left nothing for him to desire. It recorded at the outset of the History the universal peace which his patient, courageous and on the whole enlightened statesmanship had given to the world. The second reference is in the passage with which we started, and here the Emperor is named with great respect, but with no particular commendation except for his piety. But when we come to the third reference, which was written after 19 B.C., the tone is different. Apropos of the triumphs of Scipio in Spain, Livy refers in advance to its final conquest, which has 'been completed in our own times under the command and the auspices of Augustus Caesar.'

Now what did these "auspices" mean to a Roman? We have taken the phrase in modern English to denote the vaguest kind of patronage; so we forget that to a Roman the words had a solemn religious meaning. At the outset of every campaign, and before every battle, the augurs in attendance on the commander-in-chief consulted the gods in his name in the regular ritual fashion, by "taking the auspices." If the omens which these gave to the priests were regarded as unfavourable, no Roman commander (save one who promptly lost his fleet and his life!) ever dared enter on a battle. But obviously the auspices could only be taken once for the same army; and obviously they must be taken in the name of the commander-in-chief. Indeed, the Romans attached enormous importance to the reputation for success of a particular commander, for they regarded a man's fortune as being a kind of personal property. Julius Caesar's quite pious belief in his own *fortuna*, for instance, was certainly one of the things that gave his assassins their chance.

Now Livy was right in saying that Spain was conquered "under the auspices of Augustus"; but we know from other authorities that this conquest was the work of the Emperor's right-hand man, Agrippa, and there is really no reason to believe that Augustus took part in the campaign. Is it a mere coincidence that the reference to the Emperor here is so brief and perfunctory? It well might be so if Livy's old republican sympathies had been moved by the thought that the real credit of the conquest of Spain, which belonged entirely to Agrippa, was nevertheless taken by the Emperor. At all events Professor Hirst is not mistaken in tracing through these three references a decrease in the warmth of feeling with which the Emperor is mentioned.

Unjust Criticism.

Now in the light of this, come back to the curious passage about Cossus in the IVth Book. This passage has much exercised the critics of Livy; they have said, and I confess with sorrow that I have myself been among their number, that Livy's procedure in merely quoting the remark of Augustus instead of investigating the evidence for himself showed a certain indifference to exact truth; in fact that he was so interested in the Emperor's taking a hand in his History, that he altogether forgot to ascertain whether the Emperor's comment was correct or not!

Recent study has thrown an amusing light on this Imperial intrusion. In the year 27 B.C. there had been a fine pother in Rome about a certain Proconsul called Crassus, who had killed the chief of a Dalmatian tribe with his own hand and was eager to be allowed

to dedicate the *Spolia opima* in the Temple of Jupiter Feretrius. He appealed to the precedent of Cornelius Cossus; and said that Cossus, according to all the historians, had been not a commander-in-chief but only what we should call a colonel. But the Emperor would not allow any general to do what he himself had not done.

An Ingenious Arrangement.

I remember a distinguished headmaster, a high-minded and genial man, who had remained a layman until late in middle life. But when he came to be the head of an ancient school, on finding (so he told me himself) that as a layman he had to take orders from the somewhat youthful school-chaplain in every thing that concerned the spiritual welfare of his boys, promptly discovered that he also had a vocation for Holy Orders and was duly ordained. Just so Augustus discovered that Jupiter Feretrius was not prepared to accept the offering of royal spoils from anybody but the chief commander of the day, under whose auspices the war had been fought. And all Augustus' commanders were, in fact, constrained to take the auspices in the Emperor's name only, so that their victories were in theory won by Augustus. If one is inclined to smile at this arrangement, one must remember that it was precisely the fact that, under the Republic, the Roman generals at the head of their armies had been accustomed to fight under their own auspices, and very much "on their own" altogether, that had kept the whole world in turmoil for a century.

We may therefore grant to Augustus that his reasons of state were substantial enough; but now mark the sequel. It was exceedingly awkward for the Emperor's contention about the private preferences of Jupiter Feretrius, that history, as so far written, did not bear out his view in the case of Cornelius Cossus, one of the only two cases recorded in the historical period. Therefore it was an extraordinary stroke of good fortune for the Emperor, in restoring the ancient Temple of Jupiter Feretrius, to discover an inscription, only four hundred and ten years old, preserved by equal good fortune on a corselet made of linen, and written in what must have been indeed indelible paint or ink. In this, the Emperor averred on the testimony of his own eyes that the last dedicator, this man Cossus, had called himself not a military tribune, as all the historians said, but a Consul. Now this explains why Livy expresses himself in such a roundabout way. Whether Livy actually looked on the corselet and found he could not read the inscription; or whether, as one audacious scholar, Professor Rosenberg, suggests, Livy did look into the Temple and found no inscription or even no corselet at all, we have no means of knowing. Anyhow, Livy was not going to take upon himself the responsibility of making any statement in the matter; and he extricates himself from the difficulty, which he clearly felt, by falling back on the picturesque side of the incident, namely, the testimony borne to the rank of the old fifth century hero by the young Emperor. "I should count it almost a sacrilege," he writes, "to rob Cossus of such a witness."

Another scholar, Professor Hirschfeld, who has reached the more charitable temper of mature years, thinks there is no need to accuse Augustus of falsehood. He points out that the cognomen Cossus, following the two other names, may easily have been so written as to lead Augustus (who might anyhow be puzzled by the spelling of the fifth century B.C.) to take that name for an abbreviation of the title Consul. This conjecture is not improbable; and it is certainly probable that the linen corselet, made at least 410 years before, and presumably a little the worse for wear even when it was first dedicated (having been taken, pierced and bloodstained, from the body of the dead king), finally collapsed into dust in the process of restoring the Temple.

This is guesswork; but in any case it is pretty certain that Augustus was wrong. The truth is there is no reason for believing that the title of Consul could have been used for any military commander at that date. In the Twelve Tables which date from 449 B.C., only twelve years earlier than the dedication by Cossus, the chief military commanders in any year were still called *praetors*. Thence came, for instance, the use of the word *praetorium* to denote the head-quarters of the general in any army; and there is every reason for believing that the title Consul was first introduced in 367, seventy years later.

Livy's Truthfulness.

What then is the upshot? It seems certain that the enthusiasm with which Livy greeted the young deliverer in 27 B.C. had been cooled by the course of events; especially, it may be, by the severity of the punishments which had befallen a number of imprudent persons who resisted the Imperial supremacy, or even those who had been accused of a proper want of reverence, like poor young Gallus* in 26 B.C. And the passage we have considered, so far from throwing discredit on Livy's regard for truth, shows that he carefully did not endorse, though he was bound to accept, the evidence proffered by Augustus.

* "The Secret of Philae." *Discovery*, January, 1920.

The Biology of an Unfolding Bud.

By J. J. Ward, F.E.S.

The author outlines the processes which take place in the unfolding of a bud, from the stage when the scale-leaves release their hold to the completion of the leaf's growth. The photographs were taken by the writer.

With the coming of spring the brown scale-leaves, which throughout the winter have protected the rudimentary green leaves within the bud, release their grip, and the green leaves emerge to capture the sunlight energy which is built into the plant mechanism. The first pair of leaves has scarcely commenced to open before a second pair appears, and others follow in regular succession. The leaves are, of course, elevated on an axis which continually elongates until the bud has become a lengthened branch, the green leaves being arranged in an orderly precision characteristic of the particular plant species.

In the heart of the bud there is a "growing point"—an active centre where vegetable cells are evolved with which to build the plant tissues. The cells, given abundant moisture brought up from the roots, increase in size to their utmost limits, and then divide into halves, which later attain full growth and divide again. In this manner the material which forms the plant structure is continually forthcoming. Of the vital force that produces this phenomenon there is no explanation.

With the development of the cells, the internal pressure of the bud increases and the external influence of the sun causes the bud-glue (a mixture of gum and resin), which has remained water-proof and withstood the cold of winter, to soften round the scale-leaves, which then release their hold and bend back. Within the bud are the last rudimentary leaves formed in the previous autumn; they closely envelope the growing point, and the expanding cells respond readily to the increasing warmth, opening the tissues like an expanding fan.

LEAVES INSIDE THE BUD.

This magnified section of a closed beech bud shows four folded leaves inside. The central and lateral veins can be seen in each leaf.

The mere opening of the bud is, however, a preliminary activity, for the growing point then becomes more energetic than ever, continually adding new cells at its apex, largely to be used for the formation of a branch structure. As the branch progresses secondary growing points are left behind at regular intervals, each of which continues to develop on its own account until ultimately it forms a leaf. By the time the leaf has completed its growth the cells have become modified to serve special functions in the plant economy, and their active growth ceases. The cells of the main growing point are not, however, limited in this manner, but continue to multiply and provide more material as long as the temperature remains favourable for growth.

Thus the bud builds a branch to bear leaves that can be spread out to the sunlight. We have but to glance at a sycamore or a horse-chestnut tree when in full leaf to realize how effectually that function is performed. Although the first impression is merely a multitude of leaves, if the tree is viewed from a height it becomes clear that however complex the leaf arrangement is, collectively they form a beautiful leaf mosaic, each receiving its maximum share of light space with little or no overlapping. This is accomplished by the bending of the leaf-stalks and tissues under the influence of light to secure the correct angle for a full or partial exposure to the sun's rays; together with such variations of the length of the leaf-stalks, and the size of the individual leaves, as may be needed to adjust the whole to form a perfect mosaic system.

The foundation of the leaf mosaic is laid when the growing point travels from the heart of the bud,

leaving behind in regular order its secondary growing points for leaf formation. Each species of tree conforms to and elaborates its own design, and every leaf ultimately takes up a position in which it can receive the maximum light which best serves its purpose. The branch with its spread leaves is, then, nothing more than an efficient piece of mechanism adapted to carry out a particular function. That function is to gather solar energy; for while it is not exactly the sun which enables the plant to grow, light is the source of the energy which supplies the stimulus rendering growth possible. When we try to break or saw a branch from a tree, its power of resistance demonstrates how much energy has been built into the wood; it is, indeed, from the cell laboratories of green leaves that all life energy, plant and animal, arises.

It is only the green plant tissues that are able to entrap this active power from some of the sun's rays; and by means of the energy so obtained the carbonic acid gas is split into carbon and oxygen—the fundamental food-stuffs, or carbohydrates, that give vitality to a plant or an animal. Since no animal can capture sunlight energy, the green plant is the ultimate source of all food supplies. The animal may eat the plant and derive its life energy indirectly, or it may obtain it by eating the animal that ate the plant. In either case the result is the same.

It is the chlorophyll, or green colouring matter, in the leaf tissues that gives this power to the plant. Of the seven primary colours of the spectrum—red, orange, yellow, green, blue, indigo and violet—it is found that the red, orange and yellow rays are the most efficacious in the leaf laboratory; the assimilating cells absorb these rays and utilize them in building up the carbohydrates. The green pigment of the leaf, while absorbing the rays at the red end of the spectrum, refuses the green. Consequently, our visual impression of leaves is that they appear to be green, for we are viewing the rejected rays.

Since animal tissues do not possess the green colouring matter, they are unable to utilize the rays for the purpose of building food materials. The plant is the builder, while the animal merely consumes and breaks down the organized energy-yielding supplies gathered by the plant for its own use; but the sunlight energy remains. With the eating of the plant the energy changes its host from plant to animal.

Having emphasized the importance of the green chlorophyll, it should be mentioned that a dull red colour is characteristic of many kinds of young leaves. Rose leaves, young asparagus shoots and a budding hawthorn hedge are familiar examples in which such colouring appears. It is due, of course, to a substance called anthocyanin, which is dissolved in the sap and is of a protective character, serving to screen the chlorophyll from some of the rays at the violet end of the spectrum which are injurious to tender plant tissues. Being of a red colour, it allows the red rays to enter the leaf and reach the chlorophyll cells, but it refuses the injurious rays; incidentally, it is found to attract heat rays early in the year when they are

THREE STAGES IN THE UNFOLDING OF A SYCAMORE BUD.
At the end of April the scale leaves of winter release their hold (left). At the beginning of May each of the buds is fully active and the shoots begin to appear (centre). By the end of the month the bud is fully opened, the leaves being alternately arranged in pairs to obtain the maximum amount of sunlight without overlapping (right).

much needed by the young foliage. Later on, as the leaves develop, the red colouring disappears and the leaves assume the normal green colour.

Although a plant appears to grow from the soil, nearly one half of the weight of its dried substance consists of carbon derived from the air through the leaves in the form of carbon dioxide. This seems difficult to believe when a massive tree trunk is viewed, but if the solid wood is burned to drive off the water and to destroy the organic matter, the ash or mineral matter that remains (about two to seven per cent of the whole weight) represents practically all that the plant obtained from the soil. The other material has returned as gas and vapour to the air and water, whence the plant obtained them. The mineral ash is an essential constituent in the plant economy.

Green leaves, then, become the agents that beautify the whole landscape; indeed, but for the process of photosynthesis there could not be life at all, for every living animal in the fauna is, of course, ultimately dependent on the vegetable world for its food supply.

Since carbonic acid gas is distributed in the atmosphere only in the proportion of approximately three parts in ten thousand, one may wonder why the supply does not become exhausted. Undoubtedly it would if it were not being continually restored to the air by animal respiration, decaying animal and vegetable substances and the combustion of coal and gas in our homes and manufacturing works. There is always this interdependence of plant and animal life; each has its part to play in maintaining the cycle. The plant is the mechanism which collects and builds the material; the animal is the machine which breaks it down and restores it to the plant for reconstruction.

This brings us back to the tiny vegetable cells built up on the growing point, each of which was a minute speck of life substance, or protoplasm, endowed with the power to collect and control sunlight energy. Even the single cell, with chlorophyll, possesses the same power, and becomes a living plant able to take possession of matter and build a structure in which to express its own function and to reproduce its kind.

Testing the Speed of Birds by Airplane.

SINCE the speed of birds is naturally increased with fright, their maximum flight can be tested when they are in a state of alarm. In a recent issue of the *Field*, Lieut. R. W. Wicks, R.N., described the results of tests which have been made by chasing birds in an airplane. The author points out that driven birds travel at almost their greatest speed, but when "walking up" the bird is invariably shot before it has got into his stride.

The speed of the birds was recorded by reading the air speed indicator of the plane when nearly level with and travelling about the same speed as the bird. As both plane and birds are airborne the wind factor is eradicated. Pheasants, partridges and woodcock proved almost impossible to gauge by this means, but the author intends to continue experiments.

On four occasions a flight of geese was pursued, and on each occasion a fair estimate of their speed was obtained. The results were respectively 56, 53, 55 and 52 m.p.h. The attempts were made in October during the early morning flight. All the formations of birds increased speed as the plane approached and then broke off into groups.

In a Scottish estuary eight attempts were made to gauge the speed of wild duck. Two were failures, two doubtful, and four produced fairly good results. These were all nearly 46 m.p.h. It was in the early morning about the middle of November, and again a large increase of speed was noticeable during the approach. Teal appear to be very fast indeed. Many times Lieut. Wicks has seen them a quarter of a mile away and taken some minutes to catch up with them when doing 75 m.p.h. He has no really good results for these, but several moderately good results show their speed to be nearly 70 m.p.h. Most of the results were made in November and December, again early in the morning. Three quail approaching Malta from Sicily last September were pursued, and they immediately increased speed to almost their original. Their greatest speed on that occasion seemed to be about 30 m.p.h.—perhaps 35—but as the stalling speed of the aircraft was 45 m.p.h., it was largely guesswork. They were probably exhausted, having flown at least eighty miles into a fair wind.

Grouse are not at all easy to pace by this means. The mean of five attempts over a moor in Perthshire gave them a top speed of 56 to 58 m.p.h. This was in October. Many attempts to chase snipe have been met with complete failure. The quarry makes a couple of turns and vanishes. The difference in speed between a bird flying into wind and one flying down wind is double the speed of the wind. As a moderate breeze is 12 to 15 m.p.h., it will be seen that the difference is very great.

The Case for National Parks.

Ways and means of establishing national parks in Great Britain are outlined in the recent report of the National Park Committee. Granted the necessary initiative and expert assistance the Committee believes that it should be possible to preserve the amenities of typical regions at relatively little expense.*

THERE is nothing novel in the proposal to preserve selected areas as national parks. Such measures have already been taken in other countries, notably in the Dominions and the United States. But the methods adopted by other countries have varied, not only with the degree of prominence given to scientific, recreational or conservational aspects, but also with the physical and economic conditions in the country.

Possibilities in Great Britain.

Some of the methods would be clearly inappropriate in this country; it would be impossible, for instance, to contemplate game reserves similar to those of Africa and America in a country where the fauna is practically limited to birds, insects and the smaller mammals. Again, the popular conception of a national park may be derived too exclusively from the recollection of such examples as Jasper Park in Canada and Yellowstone Park in the United States, although there are many national parks in Canada and the United States on a much less heroic scale. In Sweden statutory provision is made, not only for the establishment of national parks in the popular sense, but also for the legal protection of natural features such as lakes, caves and trees.

By comparison with the Dominions and the United States, Great Britain is small, densely populated and highly developed, and has relatively little land which is not already put to some economic or productive use. These considerations alone would militate against a close copy of the American large scale model; on the other hand, they serve to emphasize the importance of taking adequate measures for preserving the countryside. But if the grandeur of the natural features of other countries is lacking, there is to be found instead an intimate charm, and an association of the land and its monuments with the life history of the race which is justly regarded as an invaluable national heritage.

The rapid progress of urbanization, the break up of large estates for building development, the extension of traffic facilities, and the eruption in places of beauty of ill-designed houses constitute a real menace to the preservation of natural beauty. The landowners, who have been for generations the chief agents in preserving and enhancing the beauty of the countryside, have in many cases sold their estates under pressure of taxation, and no other agency has so far taken their place. In many instances estates have been broken up without the slightest regard for the landscape. The situation has thus been described by the National Trust:

"In the most characteristic part of England natural beauty is disappearing at an alarming rate. The downs, the coast-line, private parks and woodlands of deciduous trees are being destroyed with increasing rapidity. The process of urbanization which has been going on for a century and a half has become much more rapid in the last twenty or thirty years. New roads are being made everywhere and are destroying old villages and trees, quiet fields and stately parks.

"The private parks of England are unique in the world. In them, as in our hedgerows, trees are grown for beauty and not for commercial reasons, as generally abroad, and are allowed to attain the special beauty of old age. Both parks and hedgerows are rapidly disappearing. Wherever parks are near enough to a town for development they are actually built over or they are in danger of it. Quarrying destroys famous hills; garish bungalows, housing a few people, ruin many square miles of those English downs which have no parallel elsewhere; factories and gas works and sewage stations are allowed to be placed where they should not be; promiscuous advertisements disfigure our fields and roadsides, and even disgrace some of the most historic and beautiful spots in the country."

Widespread Disfigurement.

The disfigurement to which the National Trust calls attention is widespread and not confined to a few districts. It threatens not only the rural surroundings of urban areas but extends also far into the country and along the coast. Moreover, the danger of spoliation spreads with every improvement of transport facilities, and areas which to-day seem

*Stationery Office, 2s.

remote and inaccessible will in the course of a few years be threatened, unless adequate measures are in the meantime taken to control the course of their development. The preservation of beauty in both town and country is a practical measure which is essential to a right economy and to the national welfare, and there is no doubt that by the exercise of wise forethought the forms of development can be made less objectionable. It is to the appreciation of this fact that we owe the establishment of the numerous local societies for preserving the countryside.

The National Park Committee is concerned not only with the general question of preservation but with the expediency of special measures for preserving the natural characteristics of selected areas. There are in this country, states the report, areas of peculiar interest to the nation as a whole, and no risk should be taken that they will be destroyed or subjected to disorderly development. The extent of the areas in question puts any policy of acquisition, whether by the National Trust or by any other body, out of the question; the total acreage of common land is large but only represents a fraction of these areas; it is manifestly impossible for the Forestry Commission to select lands for afforestation on the basis of their amenity value, although, in fact, the lands most suitable for afforestation are usually situated in the most picturesque parts of the country; and the responsibility for safeguarding areas of exceptional interest to the nation should clearly not be left to the unaided efforts of the local authorities. The first object to aim at is a systematic scheme for ensuring the preservation, for the enjoyment of this and future generations, of large areas of exceptional natural interest.

A second object which might be served by a scheme of national reserves and nature sanctuaries in this country is the protection of flora and fauna. In support of the view that efforts for the conservation of wild life were not keeping pace with the destructive agencies, it has been shown that of the total of about 1,800 species of flowering plants and ferns native to Britain no less than approximately one-sixth have become extinct in one or more counties in England or there is documentary evidence of their diminution. Of this total, about a third have become extinct in one or more counties. Apart from special cases where diminution is attributable to advance in cultivation, the evidence points to the general conclusion that the danger of extinction becomes acute where the conditions of environment have been altered. It is therefore suggested that the maintenance in their present state of areas where rare species occur would appear in general to be the best means of ensuring that future generations shall enjoy our flora, though in special cases the establishment of sanctuaries might be necessary. The disappearance or diminution of rarer species of British mammals and birds is a matter of common knowledge.

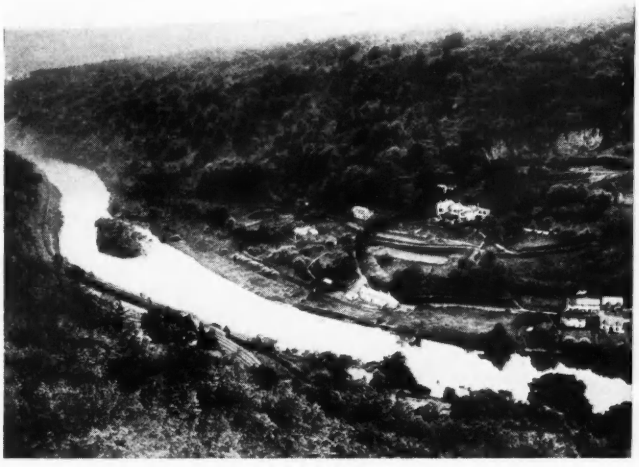
THE CORNISH COAST.

A view of Land's End, a typical example of the rugged beauty of the Cornish Coast.

It has been suggested that in this small and densely populated country it might be difficult to reconcile the recreational aspect of national reserves with the preservation of animals and plants, though the successful establishment of bird sanctuaries in the royal parks shows that these difficulties can be surmounted in the case of many interesting forms of wild life. In relatively large areas the formation of small enclosures, if suitably chosen and kept private all altogether or at suitable seasons, would serve as sanctuaries for breeding and preservation. In other cases, where it was desired, for instance, to protect the rarer types, the choice of site would have to be determined by the natural habitat of the species, and in these cases it would be necessary, as a general rule, to contemplate separate sites—not forming part of a national reserve—for nature sanctuaries.

The preservation of the natural beauties of large areas of national importance would involve, as a

speaker at the National Conference for the Preservation of the Countryside in 1929 pointed out, a power to control the whole area so that no development could take place unless approved by the proper authority. The necessity here contemplated could probably be met in a large proportion of cases by a planning scheme in which the future development of the areas would be regulated. A scheme for a national reserve would define the area under consideration, would specify those parts where no development should take place without the sanction of authority, determine the type of development in other parts of the area, and provide adequate safeguards against ill-designed buildings and the use of unsuitable materials. Areas in which development is to be made subject to the sanction of the controlling authority would be classified as private open spaces, which would remain in private ownership, or as public open spaces which the planning authority would be empowered to purchase.



THE WYE VALLEY.

The river viewed from Symond Gap Top, showing part of the surrounding woodland.

The National Park Committee suggests that this procedure would limit any interference with private ownership to what is deemed necessary to ensure that rights to ownership are not exercised in a manner detrimental to the national interest; it is elastic and can be adapted to the varying requirements of different areas; it allows scope for initiative and for securing the maximum measure of agreement between owners and local authorities; finally it admits of periodical revision and of adjustment to the march of events.

It is therefore recommended that, if public funds can be made available for this purpose, a national authority should be set up for England and Wales, with a corresponding body for Scotland, empowered to define national reserve areas, to provide expert aid in planning, and to make contributions to the cost of planning schemes, including, if necessary, a contribution to the cost of preparing a plan as well as of meeting the payments for compensation which might arise from the restrictions placed, in the national interests, on the exercise of rights of ownership and occupation. With these means at their disposal it ought not to be difficult to stimulate planning authorities to action in the required directions.

The Committee believes that as a general rule it would be found possible to make adequate provision for the preservation of national reserves by means of planning schemes at relatively small cost provided the necessary energy, initiative and ability are used with a tactful regard for local interests, and it is contemplated that the national authority would only adopt the method of acquisition as a last resort. Incidentally, the protection from misuse of those parts of a national reserve to which public access is provided will call for the serious consideration of the national authority.

If national reserves are constituted, it would be necessary not only to make byelaws governing their use by the public, but, at the outset at any rate, to enforce regulations by rigorous penalties until a community spirit has been developed. But it is clear that the habits of disorderly people will not be reformed by regulations and penalties alone, and that there will be need for propaganda in the schoolroom, in the Press, and by any other means that will assist in forming an enlightened public sentiment. It is suggested that the risk of abuse will be lessened if visitors are encouraged to organize themselves in societies. The experience of the National Trust and of other societies will suggest other methods of enlisting the co-operation of the public in measures for safeguarding national reserves, and at a later stage means may be devised for ensuring close co-operation between the national authority and other bodies concerned with the preservation of rural amenities.

As regards the protection of flora and fauna, it is probable that this object could best be promoted in England and Wales by making small grants, on a

contributory basis, to appropriate societies towards the cost of establishing nature sanctuaries. In some cases, where it is proposed, for instance, to establish a sanctuary within a national reserve, it might be necessary for the national authority to frame bye-laws for the protection of the sanctuary. In Scotland it might be more convenient to proceed by a process of scheduling, with severe penalties against the removal of, or interference with, flora and fauna. The representations made to the Committee on this procedure have not been unanimous, but the view is widely held that the publicity which would be given to an area by scheduling would have the disadvantage of attracting the attention of unscrupulous collectors, whose depredations are more to be feared than those of the general public.

In selecting areas most suitable for national reserve purposes a distinction must be made in the first place between areas selected by reason of their outstanding interest to the nation as a whole, and areas conveniently situated in regard to industrial centres, to which it is desired to provide a larger measure of access. The first group may correctly be designated national reserves. For these, preservation is the primary consideration. In the second group the question of access will be fundamental but considerations of preservation will also arise ; areas in this group may appropriately be described as regional reserves. In regard to the first group the authority would no doubt desire, so far as their funds will permit, to include at least one supreme example of each principal type of scenery, but they will also have to take other factors into consideration. They must consider, for instance, in which areas the limited funds at their disposal will yield the best results, which areas stand in the greatest danger of disfigurement, what assistance is forthcoming from local authorities, landowners and private sources, and so on.

Suggested Reserves.

It is assumed that so far as England and Wales is concerned, the national authority would pass under review in this group such areas as the Lake District, Snowdonia, a coastal area in Cornwall or Pembrokeshire, a section of the Broads and of the South Downs, Dovedale and possibly a section of the banks of the River Wye and of the Scottish Border.

It may be assumed that the improvement of access to areas within easy reach of the industrial populations will be of more vital interest to the industrial centres concerned than to the nation at large. The main difficulty which an authority would have to face here is, not to select suitable areas, but to determine which of the many areas falling in this category should receive consideration. Financial considerations are likely to require the authority to limit their efforts to areas where regional contributions are forthcoming commensurate with the regional interest of the area. In this category may be placed the proposals for improving access to an area in the high peak district of Derbyshire and to the forest of Bowland. The question of access is perhaps more important in the industrial north than further south, but a similar question arises in regard to Cannock Chase, to areas in outer London, and generally wherever the break-up of private estates or the extension into the country of industrial activity threatens the opportunities open to city dwellers of easy access to the countryside.

The Forest of Dean.

A proposal has been made to develop the Forest of Dean as a national park. The forest proper covers an area of about 18,700 acres and was transferred to the Forestry Commissioners in April, 1924. So far as the area is devoted to afforestation, it is the policy of the Commissioners to take special care of the amenities. The forest is, however, not improved by the pithead buildings which are an inseparable part of the mining industry, or by the disorderly array of villages lying within the forest boundaries. It is impracticable to do away entirely with the disfigurement associated with the mining of coal although something might be done to cover up the spoil banks ; on the other hand, the further development of built-up areas is a proper subject for a town planning scheme. The control which might otherwise be exercised is hampered by the peculiar mining rights and consequent haphazard development of the minerals by free miners. There is no power to grant leases except for mining purposes, and it is only in very recent years that an attempt has been made to secure building development on more orderly lines. A regional planning scheme is in course of preparation for the Wye Valley, covering a large area on both sides of the Wye, and it is suggested that a national authority should acquaint itself with the provisions of the planning scheme and consider whether it could facilitate the completion of the scheme.

A small enclosure within the forest might be preserved as a nature sanctuary, with adequate measures of protection. Finally, the authority would no doubt consider whether any additional measures were required for the protection of ancient monuments within the forest borders.

Scotland presents a different problem, and the question of preservation is not generally so urgent

as in England and Wales. A large part of Scotland is a potential national park, and the main problem is how to render it more accessible without unfairly disturbing the economic uses to which much of the area is at present devoted. Preservation is as a general rule a secondary consideration except in the districts adjacent to the industrial belt where it is urgently needed. Planning schemes are already in hand for the regions round Edinburgh, Glasgow and Dundee, and preservation should be adequately secured in the Lowlands.

The more remote Highland districts and Southern Uplands are for the most part protected by their isolation and by their present use as sheep farms and deer forests. The principal dangers which threaten them are excessive road development, which if carried too far would profane their solitude, and hydro-electric schemes which tamper with the rivers and lochs and bestride the country with pylons and cables. No one will deny that many of the secondary roads need improvement or that beauty may have to give way where power schemes of national importance are concerned.

IN THE LAKE DISTRICT.

A bend in the River Esk, with the famous Scawfell in the distance.

The preservation of the Highlands should be a relatively simple matter, and the measures required for the protection of flora and fauna in Scotland are simpler than those which would be necessary in England and Wales: a large part of the country is still sufficiently remote from urban development to provide a natural sanctuary for wild life. The Committee recommends that, where it is not possible to work through existing societies the Scottish national authority should be empowered to schedule as nature sanctuaries areas of special interest for their flora and fauna, to make regulations for the protection of wild life in scheduled areas, forbidding under penalties the removal of, or interference with, flora and fauna, and to appoint wardens where necessary.

It has been suggested that a national park on American lines should be established in Great Britain, and that Cairngorm would probably be the best site for it. By comparison with the larger American and Canadian examples this area is relatively small, and the principal sport, deer stalking, is incompatible with the use of the land as a national park. The cost of acquiring the land would be heavy and the value for which payment would be made—sporting value—would be lost when the area was converted into a national park. If, in the course of time, public demand and experience warranted the provision of a large area as a national reserve, the Cairngorm region presents many attractive features, both as to extent and character. In the meantime, however, the Scottish National Authority, when set up, might advantageously consider by what means it might be made more accessible to pedestrians of small means. Granted the necessary initiative and expert assistance, it should be possible to achieve a great deal in the direction of preserving the amenities of typical regions in Great Britain at relatively little expense.

The National Park Committee recommends the appointment of a national authority for England and Wales and of a similar body for Scotland. An income of £100,000 a year for five years would be required to justify this recommendation, but a great deal would depend on the areas selected, on the goodwill and co-operation of landowners and on the private contributions available. Moreover, as the liabilities of the authorities would be smaller in the earlier years and would increase in the later years, it would be more appropriate to express their requirements as a capital sum of £500,000 over a period of five years. The task of the authorities will not be an easy one. But if it is difficult it should also provide an opportunity of conserving for all time some of the most glorious examples of the works of nature in this country.

Book Reviews.

Science and First Principles. By F. S. C. Northrop. (Cambridge University Press. 12*s.* 6*d.*).

The author is professor of philosophy at Yale. His aim in this book is to determine precisely what scientific discoveries at the present time are revealing and what this revelation means for philosophy. The essentials of the book were given in lectures delivered to New York University. These were given extemporaneously. The book is in consequence racy and fresh and not so precisely arranged as a more formal treatise; there is, indeed, a good deal of repetition both of argument and of phrase. Despite this the book is written directly at the reader. The writer has made up his mind about what he is saying and contrives to say it as plainly as he can. He has read widely in contemporary sciences and taken part experimentally in one of them. He has turned the material well over in his mind. His wide range reminded us of Professor A. N. Whitehead whose pupil, we were not surprised to find, Mr. Northrop has been.

What are the first principles? In a book on modern science and philosophy one cannot expect this to be exactly answered. The kinetic-physical theory of nature in a kinetic, atomic form must be accepted as one of them. The old absolutes must go, however, absolute space, the absolute ether, absolute time, even absolute space-time. There are some absolutes in nature which remain objective and invariant through all the relativity which exists, and two of these are matter and motion. There is further a "referent," other than the "moving microscopic particles" of physics and chemistry, which must of necessity exist. It must be physical; it must surround all the microscopic atoms of the whole of nature; it must be "atomic" in the sense that it is not compounded of things. This the author calls the physical "macroscopic atom, spherical in shape and hollow in its interior." The universe is constituted of this as well as of moving microscopic atoms.

In developing his thesis and showing how his primary conceptions shed light on many of the difficulties of the understanding of modern science, the author gives good historical accounts of the subjects about which he is talking. In the first chapter he traces the rise of modern science and emphasizes how great an age is this in which we live. Its many discoveries have forced us to consider our whole philosophical outlook. It is forcing our scientists to become philosophers. Technical scientists at the present time are finding themselves with equations which they are unable to interpret, and with theories which require philosophical statements about them, unacceptable by many of their colleagues, to make them intelligible. Newton and Faraday and Clerk Maxwell got through life without breaking into philosophy; their successors—Einstein and Eddington and Whitehead in physics, Haldane and Henderson in physiology, and Weyl in mathematics—are writing or trying to write philosophy. After this review the author attempts a description of the relativity theory neither too technical nor too popular in style. Nevertheless it is hard reading, whether it be the physics of it or the philosophic asides in which the author indulges. The Special theory "did in" absolute gravitation and time and the absolute aether, and put absolute space-time in their place. The General theory swept this away; it left nothing but matter and a certain mathematical formula which specifies how the properties and distribution of matter determine the metrical structure of a variable and relative four-dimensional space-time.

From this he passes to even more recent developments in physics: the finite (and possibly expanding) universe, the new wave-mechanics and the new thinking on the second law of thermodynamics. On each of these he has something interesting to say. He makes hay of the suggestion that the whole universe is running down and must eventually land us in a state of frigid chaos and dust. (If it were, he argues, it would be bound to become built up again.) Running down in one sense and building up in another are in fact going on now and all the time.

In the next chapter, on the living organism, the author gives an account of his own work in physiology and how he was led by it to interpret afresh the age-long question of vitalism and mechanism in biology. Here his views on microscopic particles and the physical macroscopic atoms serve him well. He then passes to a consideration of his theories on mankind and ends with a chapter on the foundations of experience and knowledge. In this he discusses the attributes of God. God is not purely a spiritual being; only atheists, he argues, can so think. He has a physical body. Three of His attributes on which the author lays stress are rationality, intelligence and love of beauty. The theological consequences of the author's view of the universe form one of the most interesting parts of this exciting but difficult book.

Necrocorinthia. A Study of Corinthian Art in the Archaic Period. By Humfry Payne. (Oxford University Press. £4 4*s.*).

The Director of the School at Athens here embodies the results of long and detailed research. Corinthian art, never wholly neglected, has not hitherto been submitted to a full study in which its ceramic, its metalwork and its sculpture are correlated. This book will serve for a long time as the standard work on the subject. But let us say at once that it is not a book to be read lightly. The author is not gifted with a flowing style, nor has he the art of reducing footnotes to their essential substance. As a result the work is cumbrous both to read and to handle. But against this very unimportant criticism must be set the fact that it is essentially a book of reference.

The most important results of the author's researches are as follows. He has established the date beyond cavil of the growth from the Geometric of the Protocorinthian style and the duration of that style. For this important conclusion he has used the unassailable evidence of the excavations at Selinus. Consequently the date of the Corinthian style properly so-called can now be settled. Secondly, he has isolated the various groups, Attic, Laconian, Etruscan and others, of local imitations of Corinthian pottery. This alone is a result of prime importance. Thirdly, he has analysed all sculpture that can be classified as Corinthian and has established—though it is surprising that it should need establishing—the period and style of the Corfu sculptured pediment. Lastly, he has discussed the question of what bronze objects may be legitimately called Corinthian and what was the nature, technical and artistic, of Corinthian gold-work. It will be seen at once that these are all important questions that concern the study of Greek art as a whole.

His detailed lists of Corinthian pottery, his analysis of Corinthian epigraphy and his valuable account of architectural decoration are all alike valuable. But what will prove most

useful to the student of Greek art is his certain analysis of the Oriental influences that formed the background of all Corinthian art. Protocorinthian drawing is thus seen to follow closely and almost slavishly the originals of Hittite art. Corinthian draughtsmen, on the other hand, adapt the art of Assyria. The author's instances illustrate his thesis convincingly. Further research on these lines is essential for a study of early Greek derivative art. The conclusion that the Creto-Cypriote region was the early intermediary between Corinth and the East is an important and an illuminating one. It was first put forward by Johansen and is now amplified.

There are few criticisms that can be called for, and they are mostly trifling. I can find no full references for the Menekrates Lion from Corfu. We are not told where it is and are given a drawing and not a photograph of it. A distribution map to accompany Chapter XII would have been most useful, and an illustration of the Cypselid bowl at Boston—here finally authenticated as genuine—might have been added. On occasions Mr. Payne takes irresponsible views too seriously and wastes too much space refuting them. Langlotz's classification of Greek plastic art is treated with a critical examination, in regard to the relevant parts of it, which it in no way deserves. Jacobstahl's views on the finds from Trebenishte are seriously discussed, although they were better disregarded as trivial and baseless. Incidentally we cannot quite understand why Trebenishte, a Slav name, should have been Teutonized. The whole subject, in fact, of these north Greek finds should have been further dealt with. There is, for instance, no account at all of the Corinthian gold-work from these graves, and the author has misunderstood the character of the silver pins with "omega" heads. He uses them, by establishing a comparison with one found at Aigion, to support his otherwise quite correct theory of the Peloponnesian origin of the bronzes. But, in fact, these pins are a very well-known Iron Age type from the north-west Balkans and the Aigion example is intrusive from the south. At Trebenishte they are local objects, at Aigion they are alien, and they belong to the tenth century or even earlier in Macedonia.

It is surprising that the author has not analysed the Corinthian element in Laconian lead figures and in Laconian architectural terracottas. But, as we have said, these criticisms are unimportant. The book itself is a monument of erudition and a very fine contribution to a study of early Greek art.

The Universe in the Light of Modern Physics. By MAX PLANCK. Translated by W. H. JOHNSTON. (Allen & Unwin. 4*s.* 6*d.*).

This is a discursive but not a popular account of modern physics. For those with the necessary technical equipment, it is a valuable and most interesting dissertation. The author is one of the great outstanding figures in modern science and ranks with Einstein as a prophet of a new and revolutionary outlook. The old theory of continuous electro-magnetic waves did not account for the fact that in the continuous spectrum of an incandescent solid the energy exhibited variations and was greatest in certain parts. As a result of an intensive investigation of this puzzling phenomenon, Planck in 1901 introduced his "Quantum Theory" in which he stated that radiation is not continuous but manifests itself in definite units or "quanta"—a very close approximation in fact to the old Newtonian idea of light corpuscles. Planck's constant is expressed as a product of energy and time, and is defined as a universal unit of "Action"—a term, by the way, first used by Maupertius to define the product of length and velocity. Naturally there was considerable incredulity in scientific circles when the theory was first promulgated, but very soon its use was extended to explain other anomalous phenomena such as specific heats, photo-electricity and important questions regarding ionization. Its universal acceptance followed as a matter of course, but it was definitely revolutionary.

In this book the learned author expresses his views as to the relation between modern physics and the Universe, and it is refreshing in these days to find a clear and authoritative expression of the meaning of, and limitations in, the scope of physics. To the physicist the book is stimulating and presents a broad vision of the true end or goal of scientific enquiry, for it is stated that although "the ultimate goal of physics is probably unattainable . . . it would be a mistake to be discouraged on that account." One of the most disquieting effects of modern scientific advances has been the question that has arisen concerning the possibility of the denial by science of individual free will. Much misunderstanding, even among scientific men, has unfortunately gained ground at one time and another, and on more than one occasion it has assumed the character of a dilemma. It is well indeed to find the author of this book defining the scientific position in clear terms. He says, for example: "Human free-will is perfectly compatable with the universal rule of strict causality." Section 6 of the book is a lucid and unequivocal statement of the attitude of physics on this vexed question, and should be welcomed by those people who are inclined to regard science as hostile, in some vague way, to a philosophical or religious outlook. The book is admirably translated and will no doubt achieve several editions.

Schliemann of Troy. The Story of a Goldseeker. By EMIL LUDWIG. (Putnam. 21*s.*).

Not infrequently biography dispels a legend: Emil Ludwig's life of Schliemann bids fair to create one. Schliemann, the excavator of Troy and equally famous Homeric sites on the mainland of Greece—Mycenae, Tiryns, Orchomenos—holds an heroic position in the annals of archaeology; but Schliemann, the man, as revealed in these pages, begins to assume proportions that are titanic. His energy, his vital force and his concentration on the purpose in view are almost superhuman. His biographer estimates the number of documents from which the material for this book is drawn at not less than twenty thousand.

In spite of his title of doctor, Heinrich Schliemann was not a scholar. Born in 1822, the son of a Mecklenburg pastor, his education came to a premature end owing to the impoverishment of the family through his father's irregularities. He was forced to become an assistant in a grocer's shop. By the time he had reached his middle forties he was in a position to retire, master of a large fortune and a cosmopolitan at home in many countries, least of all perhaps in his own. He spoke and wrote in no less than eighteen languages. In his childhood a "History of the World" had aroused a desire to explore the life of the Homeric heroes; but characteristically he set aside this desire until he had established his position, not even learning Greek until late in his career, and then only as a Sunday pursuit, lest it should distract him from his business. His commercial career was an odyssey in itself. Shipwrecked on the coast of Holland on his way to America when little more than a youth, he refused repatriation and entered a Dutch business house. To a knowledge of Russian, to which he had added Dutch and English,

he owed promotion to the agency of his firm in Russia. Within a short time he established a business of his own and was visiting England and America, where at San Francisco, a far cry in those days, the great fire added to his fortune. Everywhere he went he learnt the language of the country, extended his business relations and increased his fortune. It was characteristic of his mentality and of his methods, that when he was seeking in America a divorce from his first wife, a Russian, he secured the consideration of no less than five amendments which would have facilitated his divorce in the revision of the law then taking place. On an early visit to England the exhibits in the British Museum had confirmed him in his purpose of archaeological exploration in Greece which still lay at the back of his mind; they prepared him for the impressions of later travel on the Nile, in Turkey and Greece, and in Palestine. His travels extended to India, China and Japan. He had determined on his retirement as early as 1858; but actually it did not take place until 1863, and even then he was intermittently occupied with affairs while he was making preparations for the excavations which began in 1869.

For success in business indomitable energy is not enough. Schliemann had imagination and insight, and it was these qualities as much as the means and the opportunity to excavate which brought him success. It was not fortuitous. If he believed literally in Homer as a guide in his archaeological work, he brought imagination and insight to his interpretation of the text. Hence his choice of Hissarlik as the site of his Trojan excavations in preference to the site then favoured by scholars; and hence perhaps his good fortune, to which Sir Arthur Evans refers, in his choice of the exact spot at Mycenae, where lay hidden the golden treasures of that site. It is unnecessary to recapitulate the tale of his discoveries at Troy, at Mycenae, at Tiryns and Orchomenos. They revealed a new civilization. His books have made his discoveries well known and they are now the commonplaces of the text-books, even if the story of prehistoric Greece as he read it has had to be rewritten. His methods were unscientific and his interpretation vitiated by his conviction that he had discovered the Greece of Homer. It was his energy, his courage and his insatiable thirst for knowledge that led the way in the remarkable expansion in the last sixty years of our knowledge of the history of the early civilization of the Mediterranean.

A History of the British Chemical Industry. By STEPHEN MIALL. (Benn. 10*s*. 6*d*.).

The Society of Chemical Industry, which is now celebrating its jubilee, could have chosen no better way of marking the occasion than it has done in commissioning Dr. Stephen Miall to write the history of the British chemical and allied trades. The author is well known in the industry and is thoroughly conversant with its many problems. He has, moreover, taken pains to collect information from all the leading firms. Thus he has produced what is, beyond question, the most authoritative account yet written of the rise and development of the industry, especially in the last thirty or forty years, and he has made the book extremely readable.

To the pessimist who laments the supposed lack of enterprise and scientific knowledge in this country this book should prove disconcerting. For it shows that in one section after another of the chemical industry our manufacturers have displayed a courage in risking their capital and a determination in working out theoretical results on a practical basis that deserve the highest praise. The industry has attained its present success by the untiring efforts of many individuals, whether business men or chemists or engineers. A large number of these men failed; much money and labour have been apparently—though not really—wasted in the long process of trial and error that makes up the history of this marvellous new industry. Those who succeeded in solving the triple problem of each manufacture—chemical, technical and commercial—deserve all the more credit. It is thus particularly pleasing to find that Dr. Miall has illustrated his book mainly with portraits of industrial chemists from Muspratt and Chance, Perkin and Mond, to the late Lords Melchett and Trent, Mr. C. F. Cross and Dr. C. C. Carpenter in our own day. For to these men and others of their kind, rather than to any vague and general evolutionary movement, we owe our great and thriving chemical industry.

The author deals first with heavy chemicals, paying special attention to the astonishing developments accelerated by the war and showing how Imperial Chemical Industries, Limited, came into existence. He goes on to the fascinating study of the dyestuffs industry and the less well known but possibly even more remarkable fermentation industries. Drugs and fine chemicals are followed by cellulose—the basis of artificial silk, cordite and celluloid in its many varieties such as films, insulating materials, car windows, and other indispensable articles. Other chapters deal with metallurgy, gas, coke and tar, paint and varnish, soap, cement, plastics, matches, and so on. The reader, even if he knows one section of the trade, will be astonished at the vast field now covered by the industrial chemist and at the extent to which chemical products, in one form or another, enter into our daily lives. The book is well indexed and contains at the end of each chapter a chronological table relating to that section of the industry. The historical notes on many old-established and famous firms are exceptionally interesting and would be sought in vain elsewhere.

Coral Reefs and Atolls. By J. STANLEY GARDINER, F.R.S. (Macmillan. 10*s*. 6*d*.).

The fascination of coral reefs and the mystery of their formation are no less impelling to the scientist—whether he is a biologist, a geographer or a geologist—than to the layman. The innumerable atolls which rise from the great depths of the Pacific and Indian oceans, remote from any other land, are indeed among the greatest wonders of the world. It is not surprising, therefore, that the problem of their origin should have exercised the minds of many men of science since Chamisso sailed with Kotzebue to the South Seas in 1815. Pre-eminent among the investigators of coral reefs are the great names of Charles Darwin, J. D. Dana, Sir John Murray and Alexander Agassiz. Professor Gardiner, the greatest living authority on coral reefs in this country, occupies a high position in this distinguished company. His interest in coral reefs is now of over thirty-five years' standing, five of which have been spent in careful personal observations on many reefs in the Indian and Pacific oceans.

This book is the happy result of an invitation to deliver a course of lectures at the Lowell Institute of Boston in 1930. As a result partly of its origin, the book is commendably brief and eminently clear and readable. The reader is not wearied—as in so many accounts of coral reefs—by long and detailed accounts of reefs he will never see or of complicated theories as to their possible (but frequently improbable) mode of formation. With the aid of admirably selected charts and

photographs, the author describes the various types of reefs—fringing, barrier and atoll,— the manner in which islands have been formed upon them, and the nature of corals and the other animals and plants which unite with the corals to form that community of marine organisms which we term coral reefs. He then deals with the distribution of coral reefs and has two final chapters on atolls and their foundations. In an appendix there is a concise account—difficult in the reviewer's experience to obtain elsewhere—of the islands and coral reefs of the Pacific Ocean.

Great stress is laid in this chapter on the natural history of corals and the great importance of the unicellular algae, zooxanthellae, which are invariably present in vast numbers within the tissues of all reef-building corals, and also all allied creatures of the anemone family which occur so plentifully on the reefs. This "symbiosis" between animal and plant is one of the most remarkable features of corals and there can be little doubt that it plays a very important and possibly a vital role in the life of the corals. Of the exact significance of the relationship there is more ground for diversity of opinion. There is no satisfactory evidence that the corals can obtain nutriment of any kind from these enclosed plants, the most recent experimental work, that of the Great Barrier Reef Expedition, being indeed definitely against this view.

In discussing the formation of reefs the author has wisely concentrated on atolls, for they are the real coral reef problem. He brings forward a very formidable array of arguments in favour of the formation of atoll lagoons by solution and by the action of the innumerable organisms, animal and plant, which bore into coral rock. He is definitely against the Darwin-Dana subsidence theory which has recently been so strongly supported by Professor W. M. Davis in his book "The Coral Reef Problem." Reef-building corals can only live in shallow water and, if the subsidence theory is abandoned, the innumerable atolls of the tropical oceans must all have been preceded by submarine banks. How were these formed? By a cutting down of previous islands by the sea—possibly during the removal of water from the sea following the accumulation of ice at the poles during the last glacial period,—by an elevation of the sea bottom, by a submarine eruption such as that which has repeatedly cast Falcon Island above the surface? Here indeed is endless scope for future research in which the geologist and geodicist must play a large part, for, as Professor Gardiner writes, "If we regard the question of the formation of the foundations of coral reefs honestly, we are forced to admit that all our theories and considerations are mere camouflage for our lack of knowledge." Full knowledge lies in the future, but anyone who wishes to know exactly how much is known to-day of the nature and formation of coral reefs cannot do better than read this book.

Joseph Priestley. By ANNE HOLT. (Oxford University Press. 8*s*. 6*d*.).

Lavoisier. By J. A. COCHRANE, B.Sc. (Constable. 7*s*. 6*d*.).

Makers of Chemistry. By ERIC JOHN HOLMYARD. (Clarendon Press. 7*s*. 6*d*.).

It is pleasant to have at the same time new and good biographies of Priestley and Lavoisier, to whose joint efforts we owe the discovery and naming of oxygen. Both were remarkable and many-sided men, both suffered at the hands of the ignorant populace, and both were among the indisputable founders of modern chemistry. Miss Anne Holt's memoir of Priestley is well planned and agreeably written, and the chapter on his scientific work is trustworthy though brief. The author says very truly that Priestley's "habit of rushing rapidly from one work to the next is probably the reason why much of his work was superficial." For all that, he was a great pioneer, whose influence on philosophic thought in the broadest sense was considerable. The biographer observes that Priestley's main task in his closing years, spent in retirement at Northumberland, Pennsylvania, was "to combat infidelity" because "he thought there was less religion in American than in England."

Lavoisier's career is very fully and clearly described by Mr. Cochrane, whose memoir is by far the best yet published in England. Lavoisier had a scholarly mind and a passion for work that were unusual in the high financial circles of eighteenth-century France to which he belonged. If he had had a more generous nature and had not, for example, claimed the whole credit of discovering oxygen—which he named after Priestley had told him of the "dephlogisticated air"—Lavoisier would be remembered more kindly. But his egotism must not blind us to his great merits. He made the Academie des Sciences a real force in France before and during the first years of the Revolution; like the late Lord Moulton, Lavoisier reorganized the manufacture of explosives and thus rendered an immense service to France at a critical period. He displayed the greatest readiness to help the revolutionary governments. Mr. Cochrane shows clearly that Lavoisier was condemned during the terror of 1794 not for any political opposition to Robespierre or the Convention but because he was an aristocrat; the charge that he had made illicit profits by farming the taxes under Louis XVI was never pressed and was wholly untrue. Within a year after the fall of Robespierre France was openly regretting the judicial murder of her great scientist.

Priestley and Lavoisier and many other men who have contributed through the ages to the slow development of their science are competently estimated in Mr. Holmyard's "Makers of Chemistry." This attractive and well-illustrated manual surveys the whole field from the metal workers and magicians of primitive Egypt and Sumer down to the modern chemists and physicists who have revealed the inner structure of the atom and the nature of radiation. Mr. Holmyard knows his subject thoroughly and his brief accounts of famous men and their theories and discoveries are always judicious. At the end of each period he gives a useful review of what had been accomplished in that period.

Ritual: Psycho-Analytic Studies. By THEODOR REIK. Translated by DOUGLAS BRYAN. (Hogarth Press. 21*s*.).

The author is well known to students for his researches into the psychology of religion on the psycho-analytic lines of the Freudian school. In this book, which is the first from his pen to be translated into English, he has collected four papers which were originally contributed to the proceedings of learned societies. Two deal with the couvade and puberty customs among primitive peoples respectively, and the remaining two with points of Jewish ritual. They illustrate both the strength and the weaknesses of psycho-analytic methods when applied in accordance with the doctrines of the Freudian school to the study of social anthropology.

Anthropologists have not been favourably impressed by the excursions into their field of the psycho-analysts who follow

Freud. Not only are they sceptical as to the value of the application of principles which have been deduced from the observation of psychic abnormalities to the customs and beliefs of peoples who, if primitive, are at least normal; but also they are not prepared to accept the universal validity of the Oedipus complex when applied to savage societies. Professor Malinowski, taking the Trobriand Islanders as his text, has pointed out by arguments which the Freudians have not been able to meet that an analysis which employs as its major premise the opposition of father and son, generated in an incestuous desire for the mother on the part of the latter, simply does not work in a matriarchal society; while, on the other hand, the antagonism between father and son in a patriarchal society, from which Freud argued, is there transferred to nephew and mother's brother, the person in authority. At the same time it must be admitted that the merit of the psycho-analytic schools—that of Jung as well as of Freud—has been to emphasize the fact, which anthropologists have been inclined to ignore, that when a custom or belief has been placed in its proper context as an element in the general development of culture, the underlying psychological factors, which would explain how exactly it came to take that form, have still to be probed. Thus in investigating the couvade, that curious and widely distributed custom which requires the man to simulate the pangs of child-birth when his wife is brought to bed, Dr. Reik goes behind the accepted explanation to show that it is due to the effect of the unconscious in the attitude of the man toward the woman and the child.

Of the two remaining essays, one, Kol-Nidre, deals with certain points in the ceremonial of the Day of Atonement and the matter of the oath, the other with the Shofar, the ram's horn, the oldest wind instrument known, which is used in Jewish cult, Dr. Reik starts from the enquiry as to why in Jewish tradition the invention of music is attributed to a man, Jubal, whereas in the tradition of other races the inventor is a god or a hero. Employing the method of psycho-analysis, and incidentally touching on the origin of music and the drama, he arrives at the conclusion that the original object of worship of the ancient Hebrews was a bull, afterwards converted into a ram to conform to their pastoral mode of life. He adds a note on the "Moses" of Michael Angelo, in which he suggests that Moses was himself a bull-deity who in the theocracy held the position of the rebel son in accordance with the usual complex. While these conclusions may appear in parts to be far-fetched to those who are not themselves confirmed Freudians, the examination of the early forms of Hebrew religion is stimulating and will demand further consideration.

Voice and Personality. By T. H. PEAR. (Chapman & Hall. 10s. 6d.).

There are probably special reasons to-day for an interest in voices: the establishment of broadcasting and of the talking picture, the improvement in gramophone reproduction following the advent of electrical recording, and the possible decrease in local differences of dialect under the influence of these inventions. This book, though originally suggested by broadcasting, touches upon many problems of the voice as an expression of personality. The author discusses the criteria by which the voice is often unconsciously judged, the dominence of certain vocal stereotypes in England, and local and social partialities for voices, accents and dialects. Some interesting practical experiments are described. Some of the four thousand listeners who helped the author by judging the sex, age, profession, birthplace and personality of several voices broadcast from the Manchester station may be interested to see the full report of the investigations in this book. Interesting problems are raised by the experiment. How is the judgment, concerning any particular attribute of the voice, formed in the wireless listener's mind? Does he analyse the voice, and if so, into what simple categories? Do these depend upon scientific, musical or artistic training? Does the listener compare the voice with the memory of some voice which impressed him in the past, and has now become for him typical? Is this type consciously recognized and named, or is it the unconscious cue for a certain kind of emotional experience and behaviour? There is the problem, too, of how far the stage has set up stereotypes of voices during the last century, and how far audiences have passively accepted such stereotypes as characterizing various professions. Since great success in the tests proves to have been achieved by the speakers who had learned professionally to modify their "natural" voice, the question arises whether the broadcasting of speech will be the subject of special technique, just as acting for the screen has become quite different from acting for the stage. Until television is perfected, this problem will be of the greatest practical importance.

This is a very methodical book, but it might have been made more entertaining without quite such an abundance of sections, sub-sections and tables, which give it the rather forbidding appearance of a specialized text-book. In describing the results of the experiments, two-thirds of the answers from listeners might have been omitted; they become very tedious. The author's style is pleasant.

Faraday. (British Electrical and Allied Manufacturers' Association. 7s. 6d.).

A Tribute to Michael Faraday. By ROLLO APPLEYARD. (Constable. 7s. 6d.).

A hundred years ago, in August and September, 1831, Michael Faraday discovered and made clear the principle of electro-magnetic induction upon which the whole of the electrical industries depend. The centenary is to be celebrated by the Institution of Electrical Engineers and other bodies. It should attract many readers to the two modest but competently written biographies of Faraday, the most lovable of geniuses. The admirable book published by the British Electrical and Allied Manufacturers' Association—strangely enough, without any indication of its authorship—is a straightforward biography, with sound comment on Faraday's scientific achievements. Mr. Appleyard's book, which supplements the other in various ways, is less complete, but gives more detail about Faraday's ancestry and other matters, and is very fully and attractively illustrated. Both writers do justice to Faraday's rare and indomitable patience as an investigator and to that poetic or prophetic quality of mind which distinguished him from the ordinary scientist.

We must look back from the high mountains to which science has apparently ascended in the hundred years and try to imagine the difficulties that confronted Faraday, groping in the mists on the plain, if we are to realize, however imperfectly, the magnitude of his services to physical science in general, and to the theory of electro-magnetism in particular. Both books should be widely read, especially by young scientific students who seldom know anything about their great predecessors.

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